DOCUMENT RESUME

ED 028 957 SE 006 736

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Evaluation of Mobile Science Laboratory, Final Report.
Albert Lea Public School District 241, Minn.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Elementary and Secondary Education.
Report No-DPSC-66-1057
Pub Date 69
Note-249p.
EDRS Price MF-$1.00 HC-$12.55
Descriptors-Biological Sciences, Conservation Education, *Educational Programs, *Elementary School Science, Evaluation, *Instruction, Outdoor Education, *Science Facilities, Science Laboratories, *Secondary School Science, Summer Programs

Evaluated was the educational merit of a mobile science laboratory. The methodology used for evaluation was the Planning Assistance Through Technical Evaluation of Relevance Numbers (PATTERN) system. The program utilizing the mobile laboratory was shown to induce behavioral changes in students, motivate them, and create interest and excitement about science. The report describes the history, funding, equipment, and evaluation of the program, summarizes results of the study, and presents a list of recommendations. This work was prepared under an ESEA Title III contract. (GR)

ED028957

EVALUATION of MOBILE SCIENCE LABORATORY

MOBILE SCIENCE LABORA

PROJECT OE-DPSC-66-1057

Title III ESEA 89-10

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Final Report

Contract Number 1025

March 1, 1969

ALJ ASSOCIATES, INC.

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SE006 736

Final Report

EVALUATION of MOBILE SCIENCE LABORATORY

Prepared For

Program Director, Charles D. Carpenter
Brookside Junior High School
Public School District 241
Albert Lea, Minnesota

Under

Contract Number 1025

March 1, 1969

Approved By:

Aaron L. Jestice
President

ACKNOWLEDGEMENT

The work performed under this contract was in an environment of full cooperation from the students and educators in Albert Lea. An evaluation of an experimental program is an experiment in itself and the dedicated, objective attitude of students and teachers in the evaluation reflects their interest and excitement about Mobile Science Laboratory.

To the 48 students who braved a snow storm and spent part of their Christmas vacation in the evaluation and the committee of 12 educators who spent four weekends and several other days, we wish to express our appreciation and gratitude for making this evaluation one of which we feel we all can be proud.

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GLOSSARY

PACE - Projects to Advance Creativity in Education.

PATTERN - Planning Assistance Through Technical Evaluation of Relevance Numbers.

MSL - Mobile Science Laboratory

ESCP - ESCP is the Earth Science Curriculum Project.

IPS - IPS is Introductory Physical Science.

PIA - Refers to planning, implementation and analysis which were the three major sections of each project.

National Objectives - The National Objectives refers to the set of overall national educational objectives.

Approach Level - The approach level denotes in broad concept the methods of accomplishing the national educational objectives.

Area Level - The area level states the various regions of educational responsibilities in which the approaches to fulfilling national objectives could be used.

Program Level - The program level is composed of a selection of PACE funded science oriented programs.

Function Level - The function level is composed of the present and possible Mobile Science Laboratory operational areas.

Curriculum Level - The curriculum level depicts an array of areas of science available for study in the Mobile Science Laboratory.

Categories Level - The categories level divided projects in groups of size amenable to relevance assignment.

Project Level - The project level consists of all the student projects selected for the evaluation.

Means Level - The first level of a project write-up consisting of planning, implementation and analysis.

Elementary Program - The program that uses the Mobile Science Laboratory as a supplement to the elementary science curriculum. It provides laboratory facilities where none have been available.

Secondary Program - The Mobile Science Laboratory program utilized by the junior and senior high school students during summer recess. The program consists of field trips for extended periods of time throughout Minnesota and Southern Iowa where the students perform various research and study programs in the field of science.

Basic - The Basic program is for those students participating in the Secondary program for the first time.

Phase I, II, and III - Phase I, II, and III denote participation of students in the Secondary Program for the second, third, and fourth times respectively.

Relevance Network - The detailed structuring of the total process into subsets that contain decision nodes where relevance numbers are assigned.

Relevance Numbers - The value of performing the function described at the decision node as determined by the experts.

Relevance Network Linkages - The relevance network linkages are the selected characteristics of the network options which relate them to criteria measures of the node of interest.

Criteria Measures - The criteria measures state the dimensions of the criteria relevant to the node of interest.

Relevance Guide Book - The relevance guide book is a document containing definitions and descriptions of all options and criteria in the network. It explains the option linkages and criteria measures and establishes a set of common data on which to base relevance assignment.

Node - A node is a network section consisting of a decision point and its options. Each option becomes a decision point for those options under it.

Evaluation Node - The evaluation node is that option in the relevance decision network which is being considered for the relevance assignments at any one time.

Node Relevance - Node relevance is the sum of the products of each criterion weight multiplied by the assigned relevance value under it in an option row. Each option has a node relevance for each relevance assigner.

Average Node Relevance - Average node relevance is the sum of the node relevance for each assigner divided by the number of balloters.

Branch Relevance - Branch relevance is defined as the product of the average node relevances of all connecting nodes from the node of interest to national objectives.

Percent Standard Deviation - Percent Standard Deviation equals the Standard Deviation of relevance assignment at a node divided by the average node relevance multiplied by one hundred.

Mean decile - Mean decile is defined as the average tenth into which a sample falls.

Cross-Correlation - Cross-Correlation is defined as the relation between one sample and another sample.

Transferable Learning - Transferable learning is knowledge learned in one area which enables better problem solving in another area.

Educator Balloting Session - A discussion and relevance number assigning meeting of the educators.

Student Balloting Session - A discussion and relevance assigning meeting of the students.

I. INTRODUCTION

The purpose of this contract was to evaluate the educational merit of the Mobile Science Laboratory, a project funded under a three-year PACE grant. The methodology used for evaluation has been employed in industry and medicine for planning and decision-making and is known as PATTERN (an acronym for Planning Assistance Through Technical Evaluation of Relevance Numbers). Evaluation of a PACE program particularly must of necessity be a decision process.

Under this contract, ALJ Associates, Inc. constructed a relevance network and evaluation criteria, conducted relevance assignment sessions with Albert Lea students and teachers. To these ends, ALJ Associates, Inc. representatives met frequently with the Program Director and the committee of educators. The atmosphere of objectivity that prevailed greatly enhanced the effectiveness of the evaluation.

This final report is intended both as a report of contract activity and as a thorough examination of the Mobile Science program.

This report contains the following sections:

Section I. Introduction

Section II. Results, a capsule presentation of the more significant results of the MSL evaluation.

Section III. Recommendations, considerations for program improvement which should be implemented.

Section IV. Contract Summary, a task-by-task summary of work on the contract.

Section V. MSL Description, a discussion of the Mobile Science Laboratory considering its genesis, its composition and its funding.

Section VI. Study Procedure, a presentation of PATTERN as it was applied to this evaluation.

Section VII. Analysis, on analysis of relevance results.

Section VIII. Appendices, contained study personnel resumes and comments, relevance guide book, computer flow diagram, and sample of student project cards and report.

II. RESULTS

The section states some of the more significant results which have developed in this evaluation of the Mobile Science Laboratory. For a detailed analysis that supports the results, see Section VIII.

A. General Results

The Mobile Science Laboratory secondary program clearly induces behavioral changes in its student participants. It has shown that students who had more exposure to the MSL program were better able to analyze and implement in their science projects than students in the same grade who had not had as much experience in the program.

The Mobile Science Laboratory elementary program has been a great motivational tool for use by elementary teachers in creating interest and excitement about science. The greater confidence and interest by elementary girls in science has been a direct result of the program. The general level of science education has been on the increase in District 241 and has become particularly noticeable in the last three years. The MSL program at the elementary level has been attributed as a substantial causal factor in the increase.

B. Specific Results

⇨ MSL Elementary Program

- ☆ was the most beneficial application of the MSL
- ☆ provided resource teachers to guide elementary teachers
- ☆ would have wide application in elementary in-service training
- ☆ was a great motivational device

- ★ has created interest in learning which has carried over to other subjects
- ★ has been as popular in parochial schools as in public schools
- ★ has enhanced the scientific base of the students of District 241
- ★ was the only science teaching support provided to elementary teachers
- ★ increased regular teaching of science from 30% to 85% by elementary teachers
- ★ had low student/teacher ratio of 15 to 1

⇨ MSL Secondary Program

- ★ reached 200 secondary students in the summertime
- ★ provided the student an opportunity to design his own project
- ★ allowed extensive use of the discovery method of teaching
- ★ changed the outlooks of both teachers and students
- ★ would provide in-service training in techniques of working with children and other people
- ★ gave students and teachers new feeling for each others points of view through living together
- ★ had low student/teacher ratio of 15 to 1
- ★ would provide a new kind of adult education opportunity
- ★ provided to students in working out an orderly, well-thought through approach to a project
- ★ demonstrated that progressive and immediate improvement occurs for student participants
- ★ demonstrated greater educational benefits to those students in the program for the longest times
- ★ showed that substantial improvement could be made in student analytic ability with participation in the MSL
- ★ showed that better balanced projects were done by students who had participated in the program longest

III. RECOMMENDATIONS

There is no question that the MSL Program has the critical far-reaching impact on District 241 needs for developing the science capability that is so necessary in preparing students and teachers, as well as the community for fruitful achievement in today's competitive environment of exploding technology and rapid scientific advance.

The following recommendations for program improvement should be seriously considered for implementation as the presently constituted program continues with its obvious high priority. It is imperative that the Program Director be relieved of some of his full-time teaching load to continue his excellent administration and management of the MSL program and further, that he be charged with the responsibility to implement the program recommended below.

⇨ A special Science Advisory Committee for District 241 should be immediately established to integrate the overall science program from the elementary through the secondary level to the needs of the entire community. This committee should be composed of educators, parents, students and key community leaders. Its first task should be to study this evaluation in depth and to define a technical and financial program to extend the inherent innovative characteristics of the MSL for much broader community utility.

⇨ The MSL should continue to be used as the broad-based behavioral investigative tool to further demonstrate the efficacy of this innovative evaluation technique and to enable cumulative use of experience obtained in this study.

⇨ Due to the District need for teachers trained in both elementary science and secondary field science, a significant in-service teacher training program should be implemented with credit allowance made for participants towards their salary schedule.

⇨ The elementary resource teachers should not continue in a teaching role but rather should concentrate on development of study units, providing teacher training and support as needed.

⇨ A substantially greater effort should be made to increase the availability of MSL to students outside the district.

⇨ Credits should be given toward graduation for student participation in grades ten through twelve.

⇨ Tuition fees, if required for secondary students desiring enrollment in the summer program should depend on "ability to pay" and should in no case be the limiting factor on student selection.

IV. CONTRACT SUMMARY

This final report covers the work performed under contract No. 1025 during the period from 13 September 1968 to 1 March 1969. The study tasks referenced are those submitted by ALJ Associates, Inc. in Proposal No. P7158 dated 15 July 1968. For each task, a statement of progress and the major supporting data prepared by ALJ Associates, Inc. are given.

In general, the contract progressed on schedule. Some problems arose in air freight exchanges of critical time-phased data between ALJ Associates, Inc. and the Program Director.

Every effort was made to ensure proper coordination of the program and communications with MSL personnel. In this regard 29 man-days were spent in Albert Lea by ALJ Associates, Inc. personnel, where the original plan called for 22. An additional 11 man-days were spent working with the Program Director and staff at the ALJ Associates, Inc. facilities.

Task I. Structuring the Mobile Science Laboratory Problem.

Using data collected in contract 1020 "Preliminary Evaluation Study", ALJ Associates, Inc. developed a complete relevance network for the Mobile Science Laboratory and appropriate criteria for levels where relevance was assigned. Several relevance structures were reviewed with the Program Director before selection of the final one was made. An eight-level network was developed ranging from national education objectives to PACE programs to student projects and their three parts.

Task II. Critique

ALJ Associates, Inc. met with the Program Director throughout the contract. Two meetings with a panel of educators were also held for review of methodology. The panel consisted of educators from elementary school, junior and senior high school, and the Minnesota State Department of Education. (The resumes of the Evaluation Committee are in Appendix A.) The first session reviewed overall methodology and the second session reviewed questionnaires which were distributed to provide data for the Relevance Guide Books.

The meetings with the Program Director were held alternately in Albert Lea and in Washington, D.C. They covered selection of the relevance network and criteria, review of questionnaires, and review of the final report.

Task III. Student Evaluation

All edited projects received from the Program Director were reviewed and categorized in groups. The projects were stored on 50 MT/ST magnetic tapes that were delivered as part of the contract. ALJ Associates, Inc. coded the entire relevance network and provided computer generated ballots for student relevance assignment made 27-28 December 1968.

ALJ Associates, Inc. provided seven (7) copies of all projects to be used as the Relevance Guide Book for Project and Means Level relevance assignment.

ALJ Associates, Inc. personnel monitored student assignment sessions which were led by Albert Lea educators and members of ALJ Associates, Inc.

Task IV. Data Analysis

The completed student relevance ballots were returned by ALJ Associates, Inc. where they were examined for errors and corrected. Ballot data including assigned relevance number, student name and organization, and project number where keypunched. The computer program used this data to calculate node relevance, average relevance and percent standard deviation.

ALJ Associates, Inc. then analyzed and evaluated the results for students at the Project and Means Levels.

Task V Education Evaluation

A set of questionnaires was developed to obtain information for the Relevance Guide Book to be used at the Function and Curriculum Levels. ALJ Associates, Inc. and Albert Lea educators jointly prepared a series of questionnaires for administrators, counselors, educators, parents and students. ALJ Associates, Inc. processed the questionnaires and produced fifteen (15) copies of the "Function and Curriculum Level Guide Book." "The Program Level Relevance Guide Book" was prepared from the letters sent to Project Directors and fifteen (15) copies were produced for educator use. Copies of the "Project and PIA Level Guide Book" used by students were also provided for the educator evaluation meeting held 16-19 January 1969.

Educators assigned relevance in sessions conducted by ALJ Associates, Inc. personnel. Assignment sessions for the Function and Program Levels were recorded for use in analyzing results.

Task VI. Data Analysis

All data from educator relevance ballots were checked for errors and key-punched. The computer program used this data to calculate node relevance, average relevance and percent deviation. The tapes recorded at the relevance assignment sessions were transcribed and analyzed for commentary.

Correlation and comparison of educator and student rankings and results were made as well as student and educator criteria rankings at all appropriate network nodes.

Task VII. Report

Twenty-Five (25) copies of this final report were submitted to the Program Director. An outline and draft of the report were reviewed and approved by the Program Director.

V. MOBILE SCIENCE LABORATORY (MSL) DESCRIPTION

A. Project History

The Mobile Science Laboratory program in Albert Lea developed from a summer science program conducted in 1965. The 1965 program was conducted as a pilot study to determine interest and utility of a secondary summer field science program. The principal drawback of the program was that a $15.00 fee was required from each participant. The school district provided classroom space and equipment (plant presses, microscopes, etc.) and paid instruction costs.

This experimental science program provided several half-day trips and one full-day trip each week of the session. Additional time was spent in the classroom laboratory identifying finds and planning further activities. Each of the thirty students was required to work on an individual and on a group project.

With this experience completed and evaluated as a useful, supplemental addition to Albert Lea education, an extensive planning session was held to develop a program for which to obtain a PACE grant. A wide range of community people participated including parents, educators, principals and conservation experts.

The PACE grant was obtained and the first mobile laboratory constructed. The PACE program structured the activities into two phases:a Basic Summer Science Program and a Mobile Science Program. The Basic Program was similar to the pilot program consisting of three half-day trips with two full-day excursions. Students were returned home everyday and no tuition fee was charged. The Mobile Program had the prerequisite of completing the Basic Program. It included an extended stay in the field for its thirty students.

Review of the first year of the program pointed up the need for another laboratory which was then built. The review also noted that full-time teaching responsibility of the Program Director and the MSL instructors during the regular school year had precluded either the use of the laboratory by the elementary schools or development of a coherent elementary program. Authorization for two teachers part-time to develop and to teach the elementary program was obtained, launching this program the second year.

The summer program grew to 200 students by the third year and the elementary program contacted nearly 4,300 students during its second year of operation.

B. Project Funding

The pilot program was supported by the school district and by tuition fees. The PACE grant, a three-year grant with yearly reviews, wholly supported the Mobile Science Laboratory. The first grant for 13 months (June 1966 - July 1967) was for $42,000. The second grant for 14 months (July 1967 - Sept. 1968) was for $115,000. Third grant for 9 months (Sept. 1968 - June 1969) was for $89,000.

C. Equipment

The Mobile Science Laboratory equipment consists of two trailer-laboratories, a kitchen trailer, a significant library of Field Service reference books, films and pamphlets. The first MSL trailer is a 40' Fruehauf semi-trailer which was purchased used and then remodeled. A portable 5.0 KW generator, light fixtures and outlets were installed. A variety of cabinets and work surfaces were built-in and the trailer floor was tiled. Water and heat were also installed. The trailer provided sixteen working spaces for students, an area for the instructor, a photography laboratory, and a book storage area for library. The second MSL laboratory did not include a photo lab and increased the number of student stations to twenty eight. In addition, other modifications were made to increase its operational efficiency based on experience with the first lab.

D. Evaluation Description

While the MSL is a semi-trailer with certain fixed specifications, it is considered something rather different for evaluation purposes. It was interpreted as a device built to accomplish specific educational objectives. To this end, ALJ Associates, Inc. viewed the MSL as shown in Figure V-1.

E. Applications

The MSL was used in the elementary program as a supplemental science resource and experiment facility. During a summer work session, the Science Resource teacher from the MSL and an elementary teacher from each grade met and planned a series of science experiments and lessons. The group also set forth objectives for the elementary program. The Resource teacher then developed study guide sheets to accompany each lesson.

Before the MSL arrived at the elementary school, a planning conference was conducted for all teachers there. The objectives and a review of the science units were discussed as was the supplemental nature of the activity. A tentative use schedule was set up.

When the MSL arrived at the school, the actual schedule was

Figure V-1. SAMPLE OF ELEMENT DEFINITIONS

PROGRAM LEVEL — MOBILE SCIENCE LABORATORY:

the MSL is a device built to:

1 — Use the discovery approach to learning as a teaching device
2 — Use the natural environment as a teaching device
3 — Use student responsibility and self-pacing as a teaching device
4 — Supplement Albert Lea District 241 science education program
5 — Provide more individual instruction in science
6 — Provide opportunity for study in participant-selected subject areas
7 — Provide opportunity for study in a variety of field locations
8 — Use community resources in science education

formed. Classroom teachers were briefed again on units and MSL use began.

In general, only half the class could attend at any given time. The other part of the class was monitored by a teaching aid until their turn.

Units in the MSL included shadows, magnetism, rocks and minerals, sound, machines, light, weather, electricity, and chemical change. They varied in number of lessons according to grade level. Most were taught by the Resource teacher with the elementary teacher in a supportive role.

Some field trips were made with fifth and sixth graders using the MSL, but these were of necessity of short range and short duration.

The MSL was used in the secondary program during the summer. Depending on the phase of the program, the duration of the field trip varied. The Basic Program provided three half-day trips, two full-day trips and one day in the classroom. Students were returned home after each day. Phase I provided for one three day field trip each week for four weeks with two half-day sessions a week at the school site. Phase I was run in double sessions in the third year, providing for six day usage of the MSL. Phase II and III provided for one three-week field trip with one week at the school site.

Each field trip was preceded by a planning session where the student wrote down his ideas for the project and the way he would collect and analyze his data. The students were provided general guidance and advice on request, but there was no fixed plan for action, at least in the advanced stages of the project. Students collected what was necessary and performed their experiments or mounted their collections. There was the opportunity for those desiring it to write study papers on what they had done during the project.

VI. STUDY PROCEDURE

A. Introduction

In introducing his bill to establish a President's Advisory Staff on Scienctifc Information Management (PASSIM) in the Executive Office of the President (S.J. Res. 202), the then Senator Humphrey clearly stated the need for numerical planning techniques in high government and industrial management offices and referred to PATTERN:

> "The human mind has difficulty in considering more than 10 or 20 factors at the same time in making decisions. Yet decision making problems of the space age may require thousands or even hundreds of thousands of factors and sub-factors to be considered. During the past two decades of rapid change, the human mind has remained relatively static in its capability, while the complexity of decisionmaking at certain levels of Government and industry has increased a thousand fold or more. The solution, therefore, rests with developing new techniques which will permit the decisionmaker to successfully deal with problems involving thousands of factors, but limits the number of factors which must be simultaneously considered to the limited capacity of the human mind.
>
> ".....PATTERN is definitely a milestone. (It) utilized such diverse disciplines as history and political science, economics, mathematics, science, and engineering, to incorporate into the decision-aiding techniques of equal diversity".

The above statement provides a simple explanation that becomes the very basis of the entire philosophy of PATTERN and is essential to the understanding of the methodology. The human mind is simply not capable in assimilating and correlating the multifarious data required in making a timely and knowledgeable decision. The problem is demonstrated in Figure VI-1 which illustrates the manner in which the total quantity of pertinent information increases and why the PATTERN technique had to be developed.

This is the basis of the relevance tree structure. The decision process involves the consideration of much more information than the human mind can grasp at one time. As the thought processes of the education evaluation process proceeds from broad approaches, on to areas of study, programs and functions to perform, there is an exponential rise in the quantity of pertinent information.

The PATTERN process allows one to continuously dissect the decision problem into workable elements, make the appropriate decisions with expertise at each node, and recombine the results with the computer to arrive at a meaningful decision knowing that all alternatives have been objectively analyzed.

B. General Study Methodology

PATTERN uses the principles of decision trees that have been discussed for years as one means of displaying information in a simple pay-off matrix. The PATTERN techniques have extended to the decision relevance network which offers a more lucid means of arraying information when the problem is very large. The evaluation/decision network is made up of a series of nodes and branches. The node represents the decision that has to be made. The branches represent the alternate courses of action, options, for that decision. The criteria represents the various factors, pay-offs, objectives, etc. that the decision will be based on. Those direct variables that directly couple the required information to the criteria are called measures. Each branch, representing an option, will support or meet the requirements of the decision as reflected in it meeting the criteria.

THE INFORMATION PROBLEM

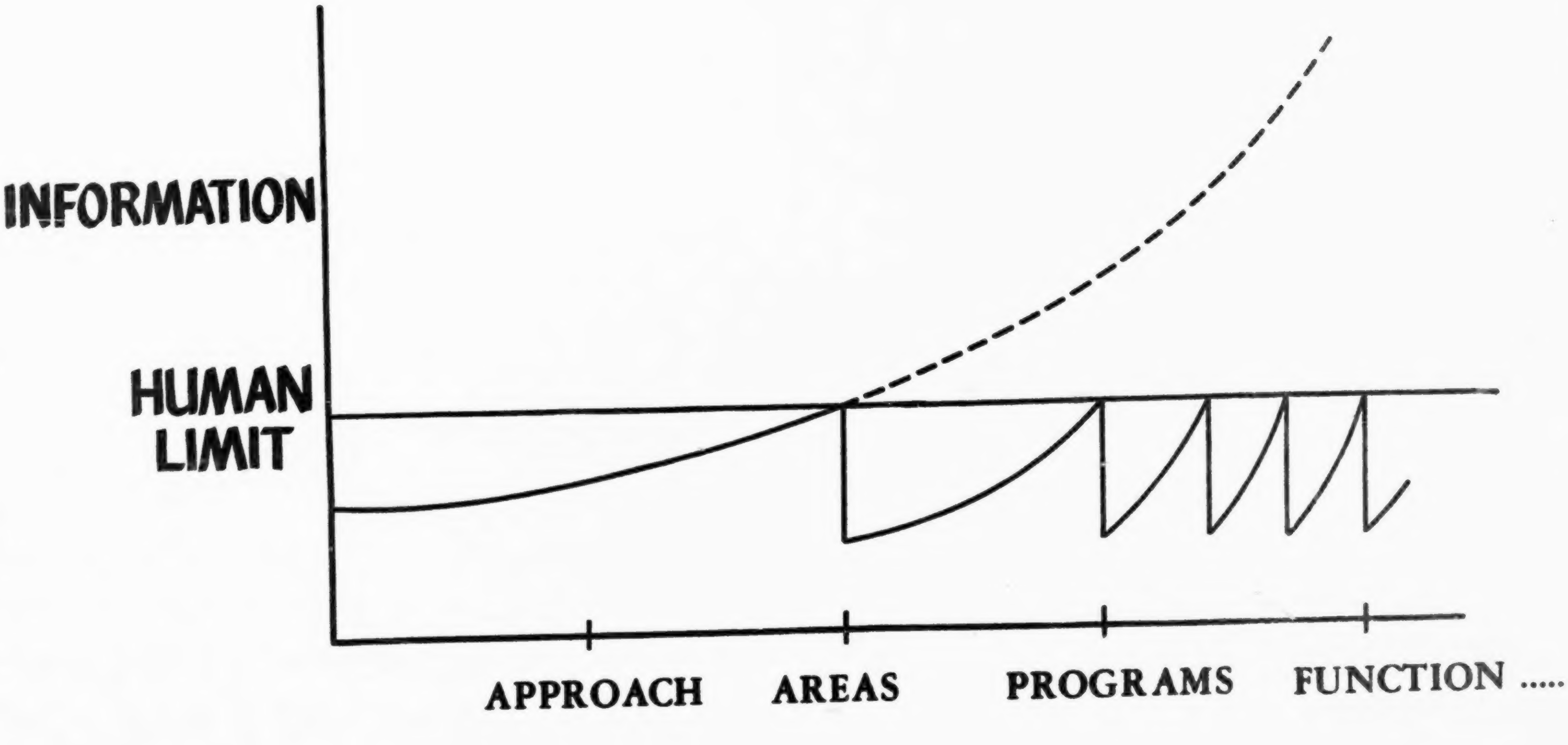


Figure VI-1.

The direct interrelationships of those factors of each option that perform the supporting function to the measures are called linkages. (A discussion follows that will describe these terms in detail.)

The wide variety of information that is required to make the decision is contained in the Relevance Guide Book. Hence, the Relevance Guide Book must contain: (1) a detailed set of definitions as to the content and impact of each decision, (2) the supporting data to allow a complete understanding of the criteria, (3) measures to evaluate all facets of the pay-off function, and (4) information that allows the assessment of the contribution of each of the linkages for each option to the criteria.

1. Network Structuring Considerations

Some of the common errors in network analysis will be discussed at this point to aid the reader in reviewing the detailed application to the MSL evaluation. It is emphasized that we are talking about a DECISION network. One of the most frequent pitfalls that one encounters in constructing a network is the subtle tendency to construct a CATEGORIZATION or taxonomy network. A simple categorization is much easier to construct and often appears in a first trial exercise. It is detected when one tries to develop meaningful criteria, which is almost impossible for a categorization network. (In this evaluation one level was purposely made a categorization level, but no attempt was made to develop criteria or assign relevance numbers.)

Another problem continuously encountered in network structuring is the tendency to want to make the number of branches equal at each node. This is normally not a subject for argument until the phase of relevance number assignment is approached. Then one becomes concerned that the option that is presented as a set of two items will automatically receive higher relevance number than an option that is in a set of ten items. The next tendency is to grab some normalizing factor to "solve" the "obvious" bias that has been introduced by not having a network structure containing an array of equal branch nodes. The normalizing technique always proposed is to simply calculate the average relevance, i.e., 1/n and multiply all the relevance numbers at each node by this factor for the particular node under consideration. It is emphasized that there is no mathematical proof yet developed that can substantiate the bias or the selection of any normalized factor to compensate for a situation that cannot be measured. All indications to date (including results of this MSL evaluation) show that the network structure can be built randomly as to number of branches, or levels which are simply means of portraying all the decisions and options. Add or subtract a branch and the definition of the node has changed and will be reflected in a new relevance number because of different criteria and information required to make the decision.

Another important consideration is the factors associated with tree truncation. If one desires to constrain the problem, either because of size, time, interest, available information, et al, (all of these necessitated a heavy truncation in this evaluation) it is often desirable to truncate a given node as lower levels of the tree are structured. This is perfectly permissable as long as the particular branch to be continued has been placed into proper perspective at the node of interest by having the other options completely defined so that one is completely sure of the information content of the continuing branch.

A node is not considered to be completely structured until all the options have been determined and related to the decision and criteria measures through their linkages. It generally requires that a less detailed network structure at all higher levels be constructed before this assessment can be determined (This was done for the MSL evaluation.) There is no mathematical need to assign relevance numbers at the level above the continuing option branch (ie, even at the decision node where it starts) as the number will factor out of the calculations and simply result in a definition of the value of the constrained set (scaling). As the truncated node is subsequently "filled out" or other nodes added, the network is simply expanded to reflect the larger set.

However, it has been found through experience that later expansion of the tree and a more meaningful understanding of a truncated network is greatly enhanced if as much consideration as possible is afforded to the higher levels that will ultimately bear on the decisions. Hence, it is well worth the initial effort to place the complete problem into preliminary perspective by totally structuring the network at higher levels to the detail of definitions, measures for the criteria, and options before embarking on a truncated version. It is not required that a comprehensive Relevance Guide Book be prepared for the higher levels, but an identification of the information considered important helps in establishing the criteria and supporting data for the lower truncated branches. The MSL Evaluation network was carefully structured so that it may be easily expanded for future work.

2. The Decision Process

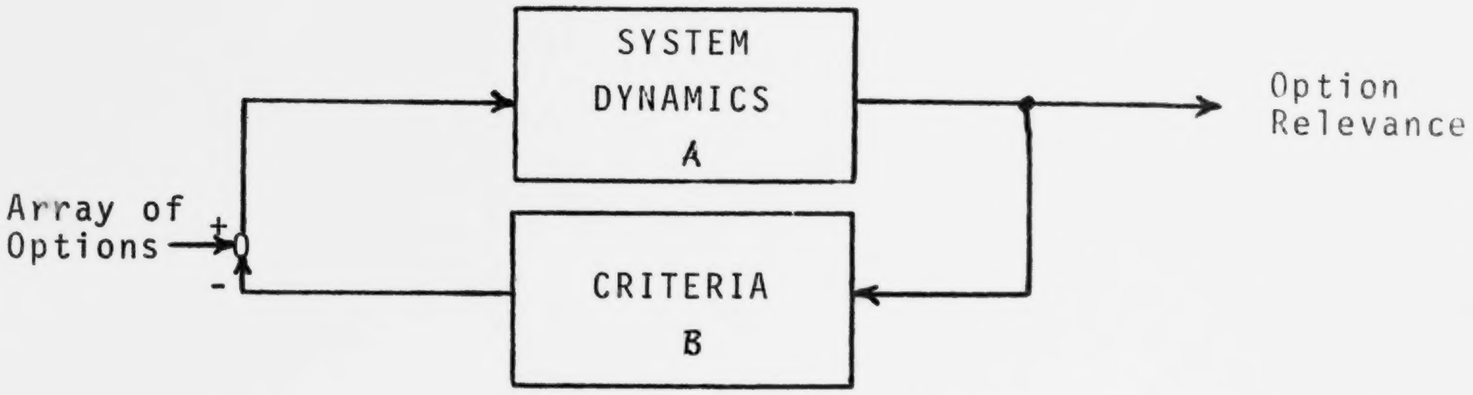
The key variables inherent in all knowledgeable decisions are a complete understanding of what is to be decided upon, the basis on which the decision is to be made, the array of options to be considered, and collection of only the information relevant to the actual decision. The network structure is used to define the problem and to present the various options that are to be considered.

The network structure has often been used to illuminate factors that have not been considered in the analysis of a complex problem and to interrelate the various alternatives. But the usefulness ends at this point unless one adds the other most important ingredient of the decision process--criteria. All decisions require some implicit or explicit basis on which they are made. *Identification of the proper measurement of effectiveness values has long been the most difficult problem facing the educational evaluation community.*

In PATTERN this payoff or objective function is embodied in the use of criteria. The whole meaning (dimensionality) of the relevance numbers is measured in terms of the criteria. The criteria are used to organize and explain the whole range of payoff phenomena in a small number of general statements, to aid in testing the option relationships and to predict their growth value, to be able to appraise the soundness of the various factors that bear on the decision, and to enable one to appraise the soundness of the decision to improve the performance over time. Hence, the criteria provide the guidance as to the complete data collection process. *One of* the most difficult problems in any decision is the overabundance of data available that appears to be of value to the decision under consideration. Most of these data really have only a superficial impact and much of it is incorrect because it was collected for entirely different purposes and contains underlying assumptions and constraints that are difficult to identify and interpret.

A direct analogy of the decision process as utilized in PATTERN can be made with the simple feedback example of a summing amplifier.

Figure VI-2 illustrates the situation.



$$T/F = \frac{\text{Output}}{\text{Input}} = \frac{A}{1 + AB} \doteq \frac{1}{B}$$

where: A = *uncompensated forward loop gain of system*

B = *feedback ratio*

Figure VI-2. Decision Feedback

It is obvious that the transfer function of this system is:

$$\frac{i^{th} \text{ Option Relevance}}{i^{th} \text{ Option}} = \frac{\text{System Dynamics Gain}}{1 + (\text{Criteria})(\text{System Dynamics Gain})} \doteq \frac{1}{\text{Criteria}}$$

where the approximation is true if the forward loop gain of the system transfer function is large, no matter how complex the dynamics may be. It is not necessary to be concerned with the internal workings of the black box represented by the system if we can understand and control it via the feedback loop expressed in terms of criteria.

However, it is very important that all facets of the criteria be included and understood as the decision is analyzed.

To ensure that the criteria are more than general statements that could be interpreted many ways they must be specifically tailored to the decision being analyzed. This is done through the use of measures as shown in Figure VI-3. For example, Economic considerations may be an important factor in the analysis at many levels of the tree. These factors may range from the GNP to the specific cost of the language laboratory for a school. The measures describe the hard factors that must be considered in the decision to determine the ultimate value of a given option. The measures must be directly coupled to the decision as they are used to establish the criteria weight and form the outline of one facet of The Relevance Guide Book.

The linkages are the factors that measure the contribution of an option to the decision payoff (Criteria). The only important factors about an option are those relevant to the measures. Hence, in considering the utility of a laboratory, for example, we assume a'priori that the equipment will work to the level of performance determined in the design trade-off analysis the Program Director makes of the various applications and their interrelationships. So what? The issue is, what are the unique characteristics about this equipment and its applications vis-a-vis its alternatives that make it an improved contributor to the educational function it is to perform. These unique charactersitic capabilities are the linkages that contribute to the payoff as expressed by the measures.

The specific details of the MSL network structure, criteria relevance guide book and number assignment process constitute the remainder of this section. It is to be emphasized that the study has shown that the principles of decision theory as embodied in PATTERN were easily applied to this evaluation. Figure VI-4 is a basic flow diagram of the process that follows.

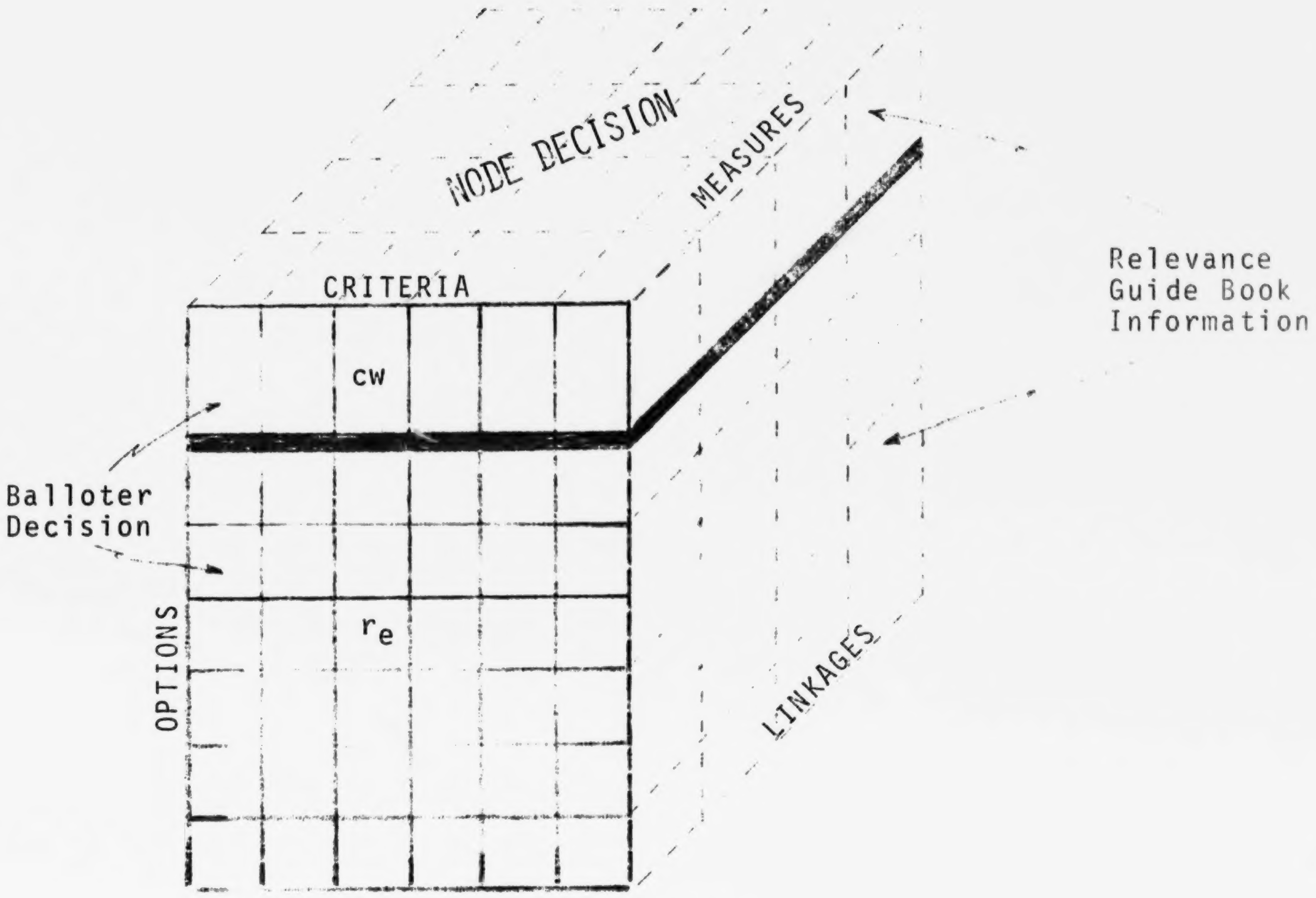
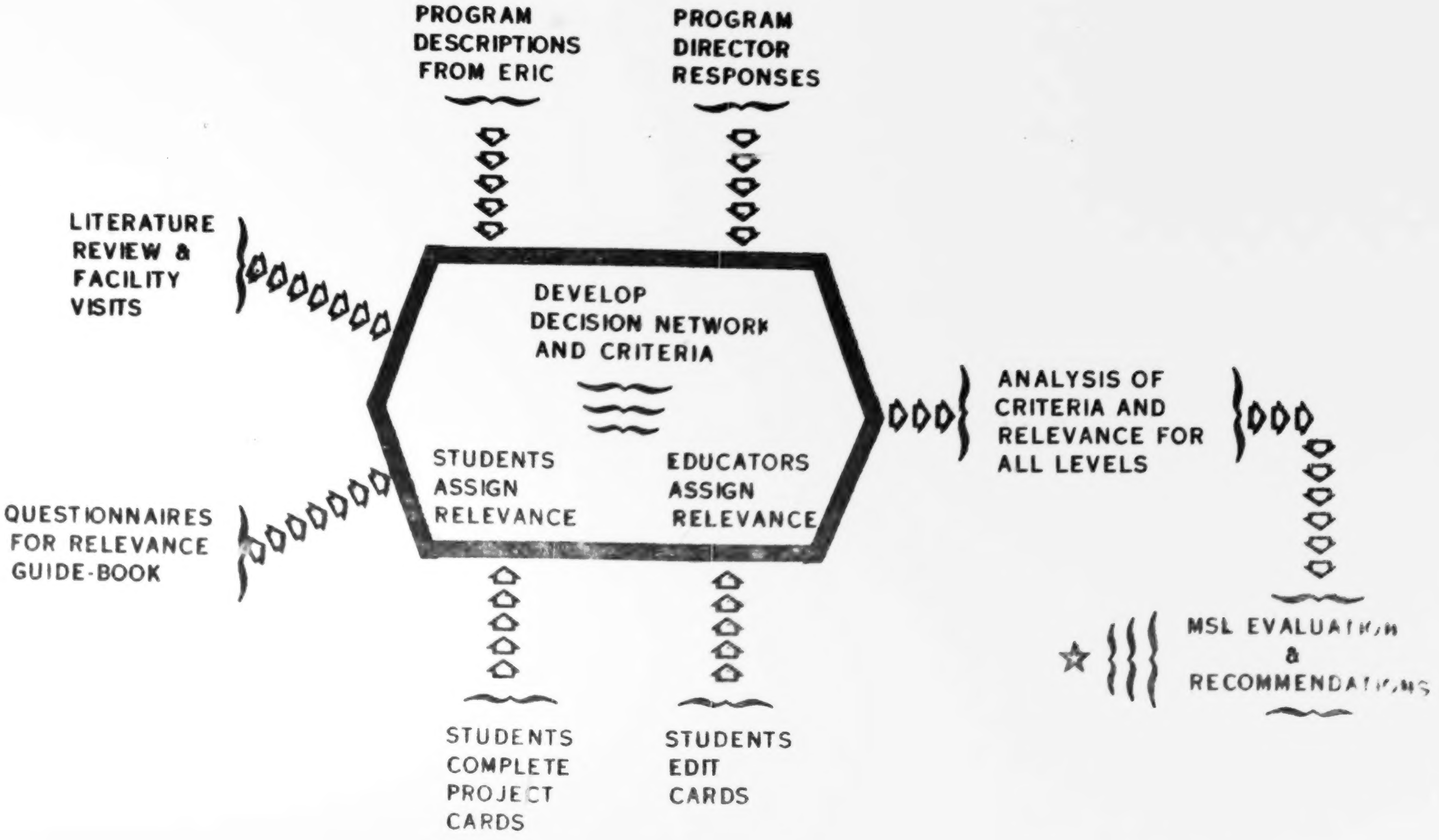

NODE DECISION
MEASURES
CRITERIA
cw
Relevance
Guide Book
Information
Balloter
Decision
OPTIONS
r_e
LINKAGES

Figure VI-3. Ballot-Data Relationships

Figure VI-4. **MSL EVALUATION FUNCTIONAL DIAGRAM**


PROGRAM DESCRIPTIONS FROM ERIC
PROGRAM DIRECTOR RESPONSES
LITERATURE REVIEW & FACILITY VISITS
QUESTIONNAIRES FOR RELEVANCE GUIDE-BOOK
DEVELOP DECISION NETWORK AND CRITERIA
STUDENTS ASSIGN RELEVANCE
EDUCATORS ASSIGN RELEVANCE
STUDENTS COMPLETE PROJECT CARDS
STUDENTS EDIT CARDS
ANALYSIS OF CRITERIA AND RELEVANCE FOR ALL LEVELS
MSL EVALUATION & RECOMMENDATIONS

C. Application to the Evaluation

1. Introduction

This section provides a detailed discussion of the application of PATTERN to the MSL evaluation.

2. Network Structure

The relevance network structure is an integral part of the PATTERN approach to evaluation. It provides the means for making a complete array of the options available to evaluators assigning relevance. The network designates the decision points and the options available at each point. A decision point (node) is not complete until every option of interest has been determined and related to the decision. The network allows examination of factors that generally have not been included in the analysis of a complex problem.

The basic principle used in structuring the network is to define the area to be investigated as the universal space and then to uniquely subdivide the space into smaller parts until the data can be evaluated in manageable pieces.

To this end, several possible networks were investigated. One of the first was that which is evidenced in the organization of the Office of Education. This structure was rejected on the grounds that it was not cogent to examining PACE projects. Another possibility was the structuring of the Elementary and Secondary Education Act. However, the development of meaningful criteria was impossible and the applicability of the titles of the law was in question. The selected structure is shown in Figure VI-5. The first level of the network was the Approach Level. This enumerated the three principal areas of activity in education. The Area Level denoted major education subject areas under each approach. The Program Level identified a

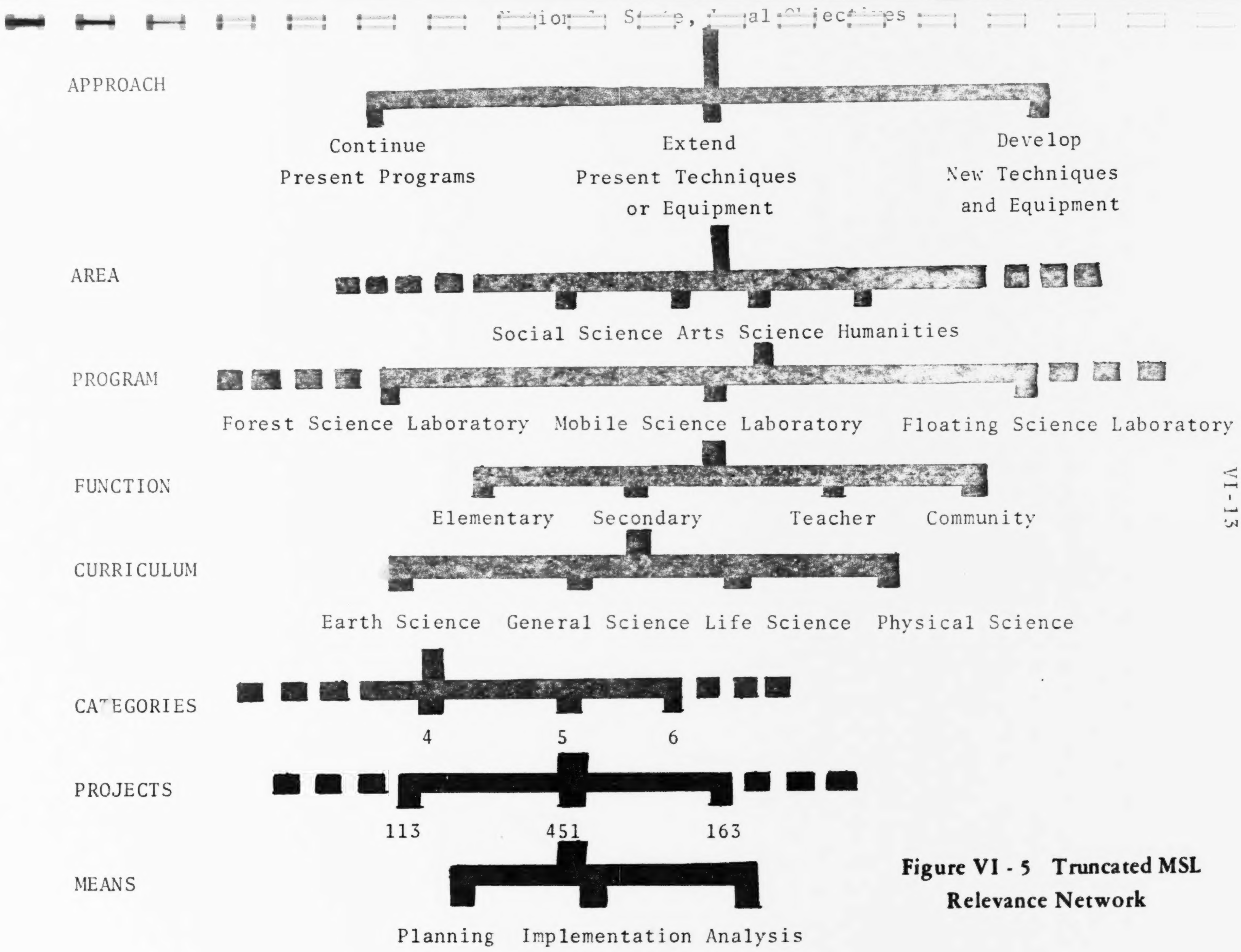

National, State, Local Objectives
APPROACH
Continue Present Programs
Extend Present Techniques or Equipment
Develop New Techniques and Equipment
AREA
Social Science
Arts
Science
Humanities
PROGRAM
Forest Science Laboratory
Mobile Science Laboratory
Floating Science Laboratory
FUNCTION
Elementary
Secondary
Teacher
Community
CURRICULUM
Earth Science
General Science
Life Science
Physical Science
CATEGORIES
4
5
6
PROJECTS
113
451
163
MEANS
Planning
Implementation
Analysis

Figure VI - 5 Truncated MSL Relevance Network

selection of PACE programs. (See Section VI. C-4b for the discussion of selection rationale.) The network was structured only under the science area, using the principles of truncation discussed in the previous section. The Function Level stated the four activities for which the Mobile Science Laboratory could have been used. The elementary and secondary uses were necessarily emphasized at this stage of program development.

Below the Function Level, activities were performed in a detailed reportable way only in the secondary area. The Curriculum Level identified the four areas of secondary science. The Category Level was inserted to classify the student projects into manageable groups. The Project Level was composed of a selection of student projects while the PIA or Means Level stated the three phases of each project.

3. Criteria

a. Introduction

A criterion is the standard by which a judgment can be formed. It is a key part of the PATTERN approach to evaluation and decision-making. The criteria form the basis on which to assign relevance. The criteria organize and explain the benefit accrued through accomplishing any one of the decision alternatives. *The relevance number indicates the magnitude of the benefit, but the criterion indicates the dimensionality of the benefit.*

For each criterion, one can develop measures which relate the specific impacts of the option to it. While each criterion makes a general statement about its unique area of benefits, the measures state the factors which are important to the criterion as the evaluator is measuring it. Only those factors stated as measures are relevant to the evaluation.

Each criterion merits a full discussion in the Relevance Guide Book and in the relevance assignment session. The discussion in both includes delineation and delimitation of criterion measures.

ALJ Associates, Inc. defined criteria at each level of the network. These criteria were discussed first with the Program Director and then with the Evaluation Committee prior to assigning relevance.

ALJ Associates, Inc. endeavored to establish uniquely definable benefits at each level of the network. These refined definitions were then presented to the relevance assignment session with the view that specific measures would be enunciated at that time.

The criteria at each level of the network are presented here with the measures determined by the committee. The complete set of factors involved in assigning relevance is therefore presumably represented.

b. PIA Level

How well did the student develop his study approach in each of the three project phases in terms of:

1. organization of thoughts and ideas
    a. continuation of the original theme of the project
    b. flexibility in planning to cope with variable situations
    c. effective use of orientation information
    d. statement of an analytic methodology
    e. clear statement of objectives
    f. statement of collection rationale

2. collection and development of sufficient data
    a. plan to collect sufficient data
    b. actually collect sufficient data
    c. analyze sufficient data
    d. handle expected problems
    e. handle unexpected events

3. completion of the three phases of the problem, accepting the student's definition of the problem
    a. completion of plan
    b. completion of implementation
    c. completion of analysis
    d. recognition of the need for further study

4. fulfillment of phase expectations
    a. closeness of approach to expected goals
    b. conclusions consistent with data collected

5. effective use of the MSL program
    a. use of all resources available in the field (personnel, equipment, facilities, location, student interaction) in each phase

These criteria had the objective of evaluating student performance on his project based on his strengths and weaknesses in developing each project phase. Planning, implementation and analysis were measured one against the others in yielding the types of benefits defined by the criteria.

c. Project Level

How well does this project compare with other projects in terms of:

1. the best use of time
    a. accomplish what was set out to do
    b. budgeted free time
    c. use of obvious short cuts
    d. level of accomplishment
    e. work constructively performed the full time

2. flexibility in coping with situations beyond the student's control
    a. amount of student planning to overcome the situation
    b. success in producing good project

3. organization of the study approach
    a. technical quality

   - b. use of scientific method
   - c. scientific quality
   - d. master plan for all three phases

4. production of meaningful results and conclusions
   - a. completion of master plan
   - b. relative to other projects, not on absolute scale

5. educational value
   - a. value to the student in assigner's opinion
   - b. competence

These criteria had the objective of evaluating student performance on his project in terms of what other students were accomplishing. Each project was evaluated against the others with regard to the measures. For example, one evaluation of student development in using the laboratory was made possible by comparing the number of years participation in the laboratory program to relevance of the project.

d. Category Level

No criteria were developed at this level since the catagories were established only to place similarly-oriented projects together for ease of comparison. It was felt that no class of projects should be valued more important than any other. For example, a project on plant ecology inherently has no more educational value than one in geology. Since no evaluation and no assigment of relevance needed to be made, no criteria were defined.

e. Curriculum Level

An assessment of the comprehensive benefits accrued by the participant in the MSL curricula.

1. physical benefits
    a. exposure to natural environment
    b. participation in sports
    c. various other forms of physical activity

2. cognitive benefits
    a. independent self-directed study
    b. extension of previous learning
    c. real-world application
    d. laboratory experience
    e. individual attention

3. social benefits
    a. group relatedness
    b. contact with community officials
    c. camping experience
    d. leadership

4. affective benefits
    a. self-reliance
    b. scientific awareness
    c. motivation

These criteria had the objective of differentiating the kind of experience to which the student was exposed. Each basic class of project required use of different materials and exposure to different individuals.

f. Function Level

1. participants (students, teachers, parents)
    a. degree of impact on motivation
    b. increase curiosity and attitudes
    c. increase knowledge and skills

    d. increase familiarity with study techniques

2. facilities
    a. increase space
    b. increase materials
    c. increase equipment

3. fulfill District 241 science education needs
    a. MSL as actually used
    b. existence of the MSL as a device to fulfill needs
    c. present strengths and weaknesses
    d. the district needs solved by MSL

4. provide increased opportunity for new teaching devices
    a. MSL potentiality of future applications
    b. function as methods and techniques medium
    c. new teaching method exposure
    d. the district needs to be solved by MSL

These criteria had the objective of evaluating the principal functions of the MSL. Each function was evaluated against the others in terms of its impact on students, its provision of facilities, its fulfillment of district needs and its potentialities. The impact of participation in the program is one of the key items in evaluation for PACE. This will provide insight into behavioral changes which are one of the important factors PACE hopes to induce. Facilities and District 241 needs are directly related to the program influence in its host area. Insight into the item of continuation of the program on a local basis will be provided by these two criteria. Increased opportunity evaluates the potentialities of the program in District 241 with inferences for PACE.

g. Program Level

1. technical performance
    a. evidence of promised behavioral changes

2. cost
    a. economic feasibility
    b. accurate cost estimation
    c. effective and efficient use of funds

3. resource usage
    a. staff suitability (size, qualifications)
    b. community-wide participation

4. innovation
    a. use of the proposed innovative techniques
    b. degree of experimentation

These criteria had the objective of evaluating PACE programs in terms of the degree to which one program met its own expectations against the degree to which the others met their expectations. It was difficult to determine the educational utility of the programs reviewed. For example, each program proposal promised certain behavioral changes. The actual development of these changes is certainly important but was hard to assess from the evaluation reports available. The innovative features of the program are important in evaluating its success. A program which is totally innovative might be more difficult to assess in terms of behavioral changes. Cost and management are always important to use of the idea by other parts of the education system. A well-managed program certainly deserves recognition for that over one that was much more expensive than proposed. Finally use of community resources to develop the program is a significant development requirement in PACE community participation in the planning stages is to be highly commended.

4. Relevance Guide Book

a. General

The Relevance Guide Book is an integral part of the PATTERN approach to evaluation. It provides the required common point of reference to the evaluators assigning relevance. The guide contains information pertinent to making knowledgable assignments of values to criterion weights and to alternative relevances. A complete guide book contains a detailed discussion of each criterion definition and its implications. It also describes options and the possible advantages and disadvantages inherent in each. The options are discussed with particular reference to the way in which they apply to each criterion.

The guide book does not attempt to promote any particular point of view, but rather presents as objective a description as its expert writers can develop. Almost any question has more than one position and, ideally, every effort is made to reflect each.

The guide book fills the need arising from the fact that few individuals are intimately acquainted with all the details of the options of the network in the wide range required, particularly in its upper part where broad choices are defined.

The evaluator who has been selected on the basis of his expertise at this particular level of the network, is presented with a complete statement of the necessary decisions, the basis on which to make the decision, and as complete an information set as is obtainable.

b. Specific Description

ALJ Associates, Inc. developed a guide book for each of the levels of the network that were assigned relevance. The guidebook at the PIA and Project levels consisted of the student projects selected for analysis. The projects were organized by general category, e.g., fish projects, insect projects, etc., and bound together. For the PIA level the relevance assigners read each individual project and made their assessment of it. For the project level the projects were compared to each other. A printed sheet stating the criteria and measures accompained the books distributed to each group.

The guide book at the Program level was developed after examination of over 200 proposals to the Office of Education. ALJ Associates, Inc. also used the responses obtained from our letters to the Program Directors of on-going PACE programs. Many of these letters evoked responses in the form of evaluations of the programs. From these data we selected nine representative programs which had sufficient data to allow inclusion in the network. Portions of the reports made available to us were selected as they applied to the criteria. The innovative features of the program and the program's evaluation of its performance were the only criteria for which information could be collected. These were included in the form of excerpts from the reports. Cost data on the programs was sketchy as was the description of use of community resources. These data should be collected through on-site investigation.

Criteria were listed in the front of the book along with the key measure on which they were to be evaluated.

ALJ Associates, Inc. developed the guide at the Function and

Curriculum levels from the responses to a set of questionnaires (samples included in Appendix B-2) which were distributed to various groups in Albert Lea by the Program Director. The groups that he selected were the school administrators, counselors, elementary and secondary teachers, secondary students, and parents of elementary and secondary students. All administrators, counselors, and teachers in the system received the questionnaires. All secondary students who participated in the program recieved questionnaires. A random sample of parents of secondary and elementary students also received questionnaires.

The questionnaires arose from the merging of a suggested set of questions from the educators' evaluation committee and from ALJ Associates, Inc. The merged set was then reviewed by the committee before it was distributed. Some delay occurred in the arrival of the questionnaires in Albert Lea because of air freight problems. The responses were to be received in Washington before the end of the Christmas holidays. Instead, ALJ Associates, Inc. received the questionnaires one week late, but their analyses and compilation into the guide book occurred in time for the assignment session in Albert Lea.

The questionnaires were designed so that each response was directed at describing a particular facet of a criterion. They were not the normal type of survey questions, although some of these kinds of questions were included to provide information to the Program Director.

The options were clearly defined at both of these levels without any necessity to expand upon them in the guide book.

5. Relevance Number Assignment Process

a. Introduction

The group of experts in the field is necessarily one of the more important developmental segments of the operation of management of a PATTERN relevance number project. These people must be the best available people in the area, and must be so fully dedicated to the task at hand that they will allow nothing to come between them and the proper assignment of relevance within the framework of Guide Book information.

The above statement fully characterizes the group of Educators that served the Mobile Science Laboratory PATTERN Evaluation. During the time that they were assigning relevance numbers they allowed nothing to interfere with their being present. They devoted many of their nights during this time to reading the background information and preparing for the group presentation of their numbers and for the presentation of their views on the Guide Book data the next day. No group could have possibly given more of themselves and their thoughts than this group of devoted Educators.

During the actual assignment sessions the amount of competition between participants in the Educator section was felt to be one of the greatest, perhaps due to the fact that these were not professional management experts, these were people who were expert in the field of education. They had experience in interpersonal relationships and decision making at the personal interaction level rather than the corporate level. This, then, caused them to be able to sense the attitudes of others more readily, and to respond immediately as they would do in their relationships in their own classrooms. In addition to this, of course, they had performed as the monitor in the student balloting sessions and therefore had an advantage that many other balloteers had not received prior to their acting in the participant role.

Additional momentum was received during the educator balloting from the fact that the balloteers were persons who had positions of responsibility in the MSL Program and in their regular assignments in the educational community. Such interest was aroused by this exposure to PATTERN that many of the Educators wished to take this useful tool with them and use its concepts in their positions in education.

b. Ballot Preparation

Where the relevance network design is approaching the final stage, a deck of holerith cards are punched reflecting the network in code numbers. In each of this same deck of cards is punched the name of an element and the identification numbers of those criteria that are applicable to this option and this node. Another deck of cards is prepared containing the names of all criteria and an identifying sequence number (mentioned above). The names of the criteria are stored in relation to these identification numbers in the computer being used, and ballot sheets are prepared for all nodes of the network by the computer. One by one, each node of the network is examined and one ballot is printed for each member of the elite group that will assign relevance numbers.

The ballot sheet is an answer sheet with spaces for the writing of relevance numbers into a blank matrix. (See Figure VI-6) At the top of the ballot can be found the name and the number of the node that is being evaluated. Beneath this will be found a short title opposite each of the numbers of the options that have been assigned to be evaluated on this ballot. Along the top of the matrix are the numbers assigned to the criteria. Along the left hand side are the option numbers. At the bottom of the page, under the last line of the matrix will be a short title for each criterion with its respective number.

This arrangement of data has been found to be most amenable for relevance number assignments and this is the way the computer has been instructed to print each of the ballots. At any time up until the actual assigning of the relevance numbers, it

'SAMPLE BALLOT'

11110205 AREA LEVEL--EFFECTIVELY EXTEND STUDENT SCIENTIFIC CAPABILITY

1111205080	CONSTRUCT FACILITY AT SITE
1111205081	DEVELOP SITE
1111205082	SPECIALIZED PERSONNEL
1111205083	CURRICULUM DEVELOPMENT
1111205084	CONSTRUCT FACILITY
1111205085	SITE VISITATION
1111205086	SPECIALIZED EQUIPMENT
1111205087	CONSTRUCT MOBILE FACILITY

CRITERIA ID	51	52	53	54		
CRITERIA WT	.30	.40	.20	.10	=	1.000
1111205080	.20	.00	.10	.25		.105
1111205081	.20	.00	.10	.20		.100
1111205082	.10	.20	.15	.10		.150
1111205083	.05	.20	.15	.10		.135
1111205084	.05	.10	.15	.05		.090
1111205085	.20	.00	.05	.05		.075
1111205086	.10	.30	.15	.20		.200
1111205087	.10	.20	.15	.05		.145
						1.000

CRITERIA	51	TECHNICAL PERFORMANCE-PLANNED VS ACTUALLY CONSTITUTED
	52	EXEMPLARY AND INNOVATIVE SCIENTIFIC EDUCATIONAL ACTIVITY
	53	COST ESTIMATES VS ACTUAL EFFICIENT APPLICATION OF FUNDS
	54	USE OF AVAILABLE RESOURCES AND STAFF

Figure VI - 6 Sample Ballot Matrix

is possible to add to or delete from the list of criteria and relevance network options without disrupting the flow of the operation. This form is especially designed to facilitate the discussion of information as it is arranged in the Relevance Guide Book.

c. Balloting Sessions

The "experts" in the field were formed into a balloting committee to consider those topics in a set of options at each node using data specified in their Guide Book. The importance of each of these options was established using the criteria explained in detail in the Guide Book.

(1) General Discussion. All of the experts were called together prior to the actual number assigning sessions and a short presentation was made of the underlying factors of each of the selected criteria. The main purpose of the general discussion is to lend uniformity to the group discussions that followed, and to give internal consistency to the interpretation of the Relevance Guide Book information.

(2) Group Discussion. After the general discussion was finished the committee broke up into uniform sized groups that were previously defined in a consultation between the Program Director and the monitor of the session from ALJ Associates, Inc. These groups were composed of people who were uniformly informed, but who also offered a variety of experiences so as to assure a high level of tension-environment information exchange. This tension is directly reflected in the high quality of the relevance numbers that are assigned by the group. Tension environment was built

question by question by this group of peers. The output of these discussions were definitive descriptions of each of the variables.

(3) Assignment of Criterion Relevance Numbers. This portion of the session was given over to the assignment of numbers to each criterion that was discussed in both of the sections above. Before he evaluated each option using the single successive criteria, (order of number assignment is unimportant), he addressed himself to the relative importance (weighing) of the criteria with respect to each other, ensuring their sum total is one.

(4) Group Examination of Numbers. Once each committee member had individually inserted his data in his matrix, all the matrices were presented to the full committee, and those who had widely divergent opinions were asked to explain why they gave that particular weight number to the criterion. This usually involves much debate and transferring of ideas in a highly tense atmosphere. At the time that there seemed to be minimum of new information being presented in the discussion, the monitor called a halt and the group goes to the next section of the session.

(5) Reassignment of Criterion Relevance Numbers. After full discussion to disclose all pertinent facts, misuse of criteria, data not hither-to brought out, etc., in order to avoid a possibility of unresolved retention of the old numbers, the first set of relevance numbers were completely discarded by removing them from the blackboard. Each member was required to reassess his position and fill out a new matrix reflecting his final decision. The second ballot was collected for calculation of the expected value and variance by the computer. These final data were then

inserted at the appropriate cell on the relevance network.

The discussions of the reasoning behind each individual's number assignment and the requirement for the committee to reconsider their intitial numbers, has a further advantage of drawing the numbers of those with limited experience in the subject area into juxtaposition with the "expert", thereby weighing his knowledge more heavily. However, this will only occur if the "expert" can demonstrate his knowledge by his presentation of facts, as evaluated in the minds of the individuals. His position and experience will have little impact on the committee unless he supports them with up-to-date facts.

(6) Assignment of Detail Relevance Numbers. Once the criteria relevance numbers were decided upon, the decision was made about the detail relevance numbers for each of the options. A word of caution was given here. There was never to be any reference to other criteria at the time of the detail number assignment. Each set of data was evaluated within the boundaries of the current criterion only, and without reference to another criterion and its importance. This is very vital to the proper use of PATTERN.

(7) Group Discussion of the Detail Relevance Numbers. The same procedure was repeated with the detail option number assignment as was observed with the criteria number assignment. The policies that were decided upon for this criterion and the boundaries of the definition were the limits within which this discussion was allowed. No reference to anything bearing on data other than this was allowed by the ALJ Associates, Inc. monitor to influence balloting decisions made at that time. When the monitor felt that there was no purpose to be achieved by further discussion, he

called a halt, and the group went to the next session.

(8) Re-Assignment of the Detail Relevance Numbers. As was the case in the assigning of the Criteria weights, these option relevance numbers were subjected to an intense scrutiny by this group of peers from the top level of administrative decision-making specialists. It would indeed be unusual if there had not been at least one number that was not assigned "in the heat of battle". It is because of these circumstances that the complete re-assignment of numbers was practiced prior to the final acceptance of any set. This was usually accomplished by the erasure from the blackboard of all of the earlier numbers and the reinsertion of everyone's latest evaluation. A short discussion was encouraged at this time to assure that the same amount of agreement still exists before passing on to the other problems at hand.

It should be observed, that there is never enough time to accomplish all of these tasks. There is always one more convincing statement that could be made, and one more of your peer's opinions that could be "shot down". In spite of this, however, one of the double checks that was practiced was to select a ballot at random and without telling the group about their previously assigned numbers to reballot one of the old sections of the data. This technique has in the past been found to duplicate the prior decisions within an acceptable statistical range as determined by no interchange of project order of relevance.

d. Relevance Number Calculations

The fundamental method followed in the assignment of numbers is kept consistent throughout the study. The functional matrix used, is represented as follows:

VARIOUS CRITERIA

Various Decision Node Options

$$
\begin{array}{c|ccccccc|}
 & cw_1 & cw_2 & cw_3 & & cw_j & & cw_m \\
 & n_1 & n_2 & n_3 & & n_j & & n_m \\
\hline
a_1 & r(e_{11}) & r(e_{12}) & r(e_{13}) & \cdots & r(e_{1j}) & \cdots & r(e_{1m}) \\
a_2 & r(e_{21}) & r(e_{22}) & & & & & \\
\vdots & \vdots & \vdots & & & & & \\
a_i & & & & \cdots & r(e_{ij}) & \cdots & r(e_{im}) \\
\vdots & \vdots & \vdots & & & & & \\
a_n & & & & & & \cdots & r(e_{nm}) \\
\hline
\end{array}
$$

a_i = i th evaluation node option ($i = 1, \ldots, n$)

n_j = j th criterion under consideration ($j = 1, \ldots, m$)

$r(e_{ij})$ = relative value of evaluation option a_i based upon criterion n_j

cw_j = importance of criterion n_j relative to the other criteria

$$\sum_{i=1}^{n} r(e_{ij}) = 1$$

indicates that if all the identified decision options are solved, the needs of the deficiency under consideration are met for the subject criteria.

$$\sum_{j=1}^{m} cw_j = 1$$

indicates that all the criteria pertinent to the evaluation of the decision options are being considered.

There are various ways that the value of a given decision option can be calculated from the data in the matrix, such as expected value, most important, expectation-variance and selection of aspiration level. Each of these could be investigated on the computer to evaluate the sensitivity of the conclusions to various calculation procedures. For this study, the continued use of the calculation of expected value was considered to be most meaningful. The expected value for each option was calculated with the following equation.

$$E(a_i) = \sum_{j=1}^{m} r(e_{ij})cw_j$$

Since there would be several people inserting data, as will be discussed below, a measure of the variance of each option can be calculated as well as the uncertainty reflected by each member. These variance data could then be subjected to different nonparametric statistical inference tests that require no knowledge of the underlying distribution, to determine the final confidence interval associated with the various recommendations. The variance for each option for each person is,

$$\sigma_i^2 = E(a_i)^2 - [E(a_i)]^2 = \sum_{j=1}^{m} r(e_{ij})^2 cw_j - [\sum_{j=1}^{m} r(e_{ij})cw_j]^2$$

illustrating that his uncertainty with regard to the various decision options as well as his assessment of the relative merits of the criteria will be included. One way of illustrating how the process was followed is to present a hypothetical example.

EXAMPLE: Assume that the committee has decided that the various decision options that are required at the project level to meet the stated objectives are Planning, Implementation and Analysis. Assume the importance of each of these options is to be established using the criteria of Organization of thoughts and ideas; Completion of each phase objective; Collection and development of sufficient data; and Fulfillment of project expectation. Each committee member would be given a matrix with the ordinate representing roles and the abscissa representing the criteria. Suppose he fills it in as follows:

Criteria No.	51	52	53	54	Individual Node Relevance
Criteria Weight	.2	.3	.3	.2	$E(a_i)$
Planning	.4	.1	.05	.4	.205
Implementation	.2	.4	.4	.1	.30
Analysis	.4	.5	.55	.5	.495

Relevance No.

51	Organization of Thoughts and Ideas
52	Collection and Development of Sufficient Data
53	Completion of each Phase Objective
54	Fulfillment of Project Expectations

Note that he determines the relative importance of each option, as viewed objectively from this relevance node perspective using the Relevance Guide Book data previously generated, using one criterion at a time, ensuring their total is one. Since the only factors he will have to consider are the individual criterion at each judgment point, he will not have to hazily evaluate the interrelationships of many variables. Note that he will not be tempted to use organization or individual biases. (This also has a cautionary consideration regarding the importance of selecting meaningful and comprehensive criteria.) After he has evaluated each option using the single successive criteria, (order of number assignment is unimportant), he then addresses himself to the relative importance (weighing) of the criteria with respect to each other, again ensuring their total is one. *The expected value and variance of his decisions are calculated and entered as shown, but would not be done by him in the actual case.

VII. ANALYSIS

A. Introduction

This section contains the analysis of the relevance numbers assigned by the educators and students. The analysis is presented according to the various levels of the evaluation network. The basic set of computer rankings are also included.

B. Analysis of Program Level Relevance Numbers

1. Introduction

The Program Level of the network is the highest point that directly couples the MSL with the PACE program. As was explained in Section VI-B, the principle truncation does not require that any structuring occur at this level. However, to ensure that the MSL was placed in proper perspective, nine other PACE programs were selected to comprise with the MSL the Program Level. The contribution of these programs to national educational objectives was measured in terms of:

1. technical performance
2. cost
3. resource usage
4. innovation

The committee of 12 educators assigned weights to the above criteria and relevance to the selected programs.

2. Criteria

The criteria were selected to reflect the points that a decision-maker needs to consider when evaluating programs. They are a measure of the degree to which the program contributes to accomplishing national educational science objectives. Programs were not compared to each other, but rather they were evaluated on the degree to which they accomplished the objectives they had set for themselves in terms of the criteria.

To make this evaluation, the educator group was provided the "Program Level Relevance Guide Book." The guide book contained appropriate data on each program. As is noted in Section VI. C.4., the Program Level book contained data on only two of the four criteria. No data was collected on either cost or resource usage. These criteria were defined, however, and were assigned weights. The average criteria weights are shown below:

	AVERAGE WEIGHT
1. technical performance	.32
2. cost	.15
3. resoruce usage	.18
4. innovation	.35

Criterion 4, innovation, received the highest average relevance. Most gave it .35 or .40, although one educator assigned it a weight of .25. The criterion was interpreted as measuring the degree to which the innovative techniques proposed for experimentation were in fact developed. The educators felt that the principal purpose of PACE funding was to experiment and this was their rationale for assigning the weight.

Criterion 1, technical performance, received the second highest weight. All educators assigned it .30 or .35. The criterion was interpreted as measuring the degree to which the desired behavioral change was exhibited by participants to the project.

The rationale was that educators are seeking to induce behavioral change in students and that programs which induce change should be highly rated. There was much discussion about rating criterion 1 or 4 highest. Most ranked innovation highest, three ranked innovation and technical performance equal in importance and one ranked technical performance highest. The group felt that innovation and technical performance should count for almost 70% of the decision in determining program value.

Criterion 2, cost, ranged from .10 to .20 in weight. It was interpreted as accurate estimation of costs and economic feasibility. All educators felt that cost was an important consideration, but that inducing change or attempting innovation was much more important. Cost ranked last among the criteria.

Criterion 3, resources usage, ranged widely from .10 to .25. This criterion was interpreted as contribution of community resources and staff qualifications to program developement. This was considered to be substantially less important than innovation.

Educators felt that experimentating in new techniques was most important in a PACE project, followed closely by verification of the technique. The educators would credit both highly experimental and highly successful programs.

3. Program Relevance

At this level, relevance numbers were assigned without discussion. This approach was taken because of the nature of the level. In making assessments, the group was to compare the program only to its own statements as printed in the guide book. Allowing no discussion caused higher standard deviations than at other levels.

The program rankings are shown in Figure VII-1. The Mobile Science Laboratory and the Floating Science Laboratory ranked one and two. Every educator ranked the MSL best at fulfilling its objectives in its own terms. Most educators ranked the Floating Science Laboratory second.

It is clear that the evaluation team found that the Mobile Science Laboratory had well fulfilled its objectives.

4. Conclusions

The educators felt that the most important factors of a PACE program are its innovativeness, followed closely by its success at demonstrating results.

The MSL was found to fulfill very well the objectives it had established for itself. It was rated particularly high on the innovation criterion.

C. Analysis of Function Level Relevance Numbers

1. Introduction

The basic evaluation performed at the Function Level is an assessment of how the MSL enhanced the overall District 241 science program in the elementary, secondary, teacher and community areas. The criteria were selected to measure the value of the program use to *all participants* through augmenting their curiosity, knowledge, skills, motivation, attitudes, and general familiarity with science, and through increasing the space, materials, and equipment available to instruct in laboratory science. Evaluation at the Function Level aided in assessing the current configuration of the MSL (considering future funding would be used for operational costs) and in determing how the program might be modified with development funds to meet future District 241 educational needs and to provide even greater opportunity to use new teaching devices such as the discovery method, natural environment and participant self direction.

A detailed examination of the factors underlying these numbers was conducted. There was no case on any assignment sheet where this trend was different nor was there a combination of circumstances that would change this order. On specific criteria, as was expected, individuals differed in their order of preference but this did not change their final calculation.

The team found close agreement on the values for the elementary and the secondary functional usages, but were somewhat less convergent to a unified position for the teacher and community usages. The latter relevance numbers are, however, well within acceptable tolerances and do not effect the final order even when the extreme values are used to calculate relevance.

2. General Conclusions

The team concluded that the MSL program of development of the laboratory and an appropriate curriculum, followed by operational use was a huge success particularly with regard to the scientific opportunities offered to the elementary and secondary students through direct participation and use of facilities. It is also important to continue this basic program with more emphasis being placed on the teacher in-service training using present facilities. However, the results show that the team feels that since the MSL program has achieved a considerable degree of maturity and operating efficiency, other means exist that should be enthusiastically explored to move faster in the direction of further meeting District 241 needs and of further providing new opportunities for teaching techniques.

3. Specific Conclusions

The evaluation committee felt that the elementary program of the MSL has proven to be the most beneficial application (the description of the various programs is found in Section V of this report). There were no complaints on any facets of the operation of this part of the program. The elementary principals readily scheduled class assignments to place more emphasis on science. When the lab is at their school. While elementary teachers made little effort to develop specific science units themselves, they were able to use with confidence those units developed by a committee of teachers directed by two resource teachers associated with the MSL. The resource teachers were able to help overcome the typical elementary fear about teaching science, since many have continued to use MSL study units and materials in their science program after the MSL has been moved to a different location. These MSL teachers are nearly full-time and are not the normal resource support personnel who simply collect science materials and books, conduct occasional in-service training or act as teacher aids on an infrequent basis.

It was considered that the majority of elementary teachers are rather poorly prepared to teach science. The majority have not taken more than the minimal amount of science since most decided to specialize in other areas of the wide variety of subject matter they are required to teach. The lab would have real application to elementary in-service science training. The whole educational science outlook of the district could be enhanced as far as teacher training is concerned. Little effort has been made in this area, however, since the resource teachers have spent most of their time either with the students or in preparing the units that were being taught.

There has been a considerable increase in science interest among the elementary students. This has been specially noticed among girls, possibly due to the women MSL teachers. The students demonstrated a much better understanding of science, and the MSL has proven to be an important motivative device. The MSL has been especially suited to use at the local park where 1,200 students have met with reource people and collected items for study. The team felt that the benefit of this activity was in far greater proportion to the actual time spent during the trips. The children were quite excited about science after each of these short visits to the field. There has been a carry-over of this curiosity to learning other subjects in the elementary classes. The carry over has also been reflected in discussions and simple experiments conducted at home as a result of the child's participation in the MSL.

These same advantages have also been seen at the parochial schools which use the MSL on a shared basis. One of the local parochial schools will be closing at the end of this school year and there is extreme difficulty being created at the other parachial school because of the lack of continuing Federal funds to use the MSL to support this school's program during the next year. The program also includes migrant worker's children when they are in the area as well as for special education classes in the district. These special classes are for students with emotional problems or some functional problems such as in reading or math.

One of the basic advantages of the elementary program over the secondary program is that the entire student population of approximately 4300 students is utilizing the laboratory, while in the secondary program approximately 200 students are trained each year. It was fully recognized that each elementary student got relatively few number of hours of specific individualized training, while during the summer program, which lasts roughly 10 to 12 hours a day during four weeks, each student got much more detailed attention during his activities.

The MSL program supplements the science studies of all elementary students and has been in existence for enough time for the junior high teachers to see a consistent improvement in the science base of the students entering their program. This has a direct influence on creating the appropriate atmosphere for acceptance of the exploratory laboratory-centered approach to science teaching using the ESCP and IPS laboratory and investigative curriculum.

It was strongly felt that in the case of the elementary teachers, the lab provided the only support they had in teaching their science program. In fact, it was felt that the science program in the elementary school would probably be 20 to 30% of the present level without the laboratory. Some of the classes would just be offering the book and going through the motions during the year. However, with the use of the laboratory, teachers are more committed to focus on science. Teachers are also given an opportunity to get help from the special teachers who have been turned into science coordinators or science consultants for the district. Now instead of about 30 to 40% of the teachers teaching science, the committee felt that about 80 to 85% of the elementary teachers are involved in the science program. One direct reason for this is that the two excellent laboratory specialists in the elementary program have become science coordinators for the entire District 241, in addition to developing in all schools the technological base offered by the laboratory.

Much work still needs to be done to augment the elementary science program. The committee thinks that science cannot be taught at the elementary level on a short-term exposure basis, such as having a specialist coming in one day a week and holding classes. Science should be introduced into the classroom every day without waiting for the science lab to come. Also, there is considerable expressed interest in using a science program in the summer time for the elementary students.

In the secondary area, the MSL contribution was also dramatic, pointing up the need for the summer program. This summer program is an extension of time at a period when science teaching can be more effective because of the living environment offered by the MSL. The MSL has been demonstrated as a stimulating purposeful program different from the regular school year. It has given the student a block of time in which to pursue a particular project without interruption of bells and jumping from one subject to another--an opportunity to follow an interest of his own choice with the help of special teachers, equipment, and scientific tools and techniques. There is a need to enhance the understanding of the interrelationships that occur in field situations. (The specific benefits of this program in terms of the growth of the student capability through participating in successive years will be discussed in the following section.) This payoff tends to come in the change of attitude that is occurring for various people in terms of better relationships with their children, new programs in the district, and better grades for their class. It was felt that this district is basically a conservative one, yet it is not doing conservative things. The only real variable in the science arena has been the MSL. Therefore, it appears that it would have to be considered very strongly as the casual thing that is changing some of the attitudes and ideas.

In the secondary area, teacher training has been enhanced by involving the people in a formal one-week job course. However, those that participate during the entire summer are receiving significant in-service training which is having quite an impact on their program in the school. The living philosophy that the program gives them reinforces the attitude change started in the week-long course, but the actual attitudes of the teachers shift radically through living with the students in the field on the program.

It was felt that the typical secondary teacher fallaciously believes he does not need in-service training while the elementary teachers indicate a need even in fields of their specialties. Efforts have been made in some of the local teacher colleges to have their students practice teach in the lab. These overtures have to date been rejected for a variety of reasons including tight scheduling. The kind of in-service training that the MSL could offer would be techniques of working with children and with other people. This is something every teacher should want to know more about.

The team feels that considerably more emphasis should be placed in the area of teacher training, especially in support of the elementary program. They felt quite strongly in their relevance assignment that the introduction of the laboratory activities in the elementary level was building a long-term base for enhancing the total scientific capability that would permeate through the secondary schools to the community. The formal in-service training for the teachers in the MSL program has been minimal. However, by the participation of the teacher during the school period, when their students were part of the laboratory, greatly augmented their knowledge of science. The committee feels that considerably more effort should be spent in attempting to utilize the laboratory for development of new techniques, while continuing to work on the same basic techniques with the current program. Considerable emphasis should be placed on developing the teacher relationship with children rather than training in very specific subject matter in a traditionally oriented way, such as learning more subject matter or getting more ideas to do a more effective job in the classroom. In the secondary area, where the teachers have the skills and the subject matter knowledge, they tend to focus on environmental relationships with students. The laboratory at the secondary level gives a teacher the opportunity to live with the student for three weeks in the field. The teachers attitude toward the student is completely different than it was before. The student is no longer a thing, he is a person. This is indeed a unique type of in-service training that is being offered.

The group felt that considerable work should be done in the area of community activities to increase local awareness of the innovative capabilities that exist and of the public image that the Albert Lea district has achieved at the national level. This is evident both by the many organizations wanting to borrow the laboratory and by those who visited it wanting to emulate its operations and to identify the problems associated with it. Considerably more work should be done toward forming a strong core of directors, leading citizens in the community that would take an interest in the over-all scientific program and aid the school program in continuing the laboratory and expanding its innovative characteristics. This public relations spirit could be culminated in a series of special adult education classes, that if characteristic of other school districts, would have a tendency to enlarge in their applicability.

The Albert Lea district does have several opportunities for formal adult education classes and the group feels that there will continue to be a great drift toward the vocational area. There is a state vocational school being planned as well as an existing adult school that deals with hobbies and vocational training. However, there has been no effort in the pure science area. The group was unable to be as specific in their consideration in this area because of the lack of experience and this is reflected in the higher per cent relevance deviation, in terms of their agreement with respect to the type of new investigations that should be conducted for the community level. However, the strong feeling was that the program is now developed to a point where considerable time could be devoted to this area. No one wished to sacrifice the additional work that should be done in the basic program especially in the elementary study activities for the community activities.

The group felt very strongly that considerable effort should be placed in developing a new innovative program use for this laboratory. Some of the opportunities discussed in detail were such programs as equipping the laboratory as a math-computer facility for software training, equipping the lab in the winter for a special kind of program that couldn't be put in the school--such as a cold weather ecology study to be used for teacher training aid as well as for students, creating teacher interest and student interest in new scientific capabilities using techniques in the field of advanced astronomy, television-communication electronics, study of the lakes and agricultural investigations. For example during the winter in addition to having the laboratory placed beside an elementary school, it could be equipped with a special type of instrumentation and pulled next to a high school where the gifted students and highly motivated teachers could come together and do advanced studies in science, covering fields that they would mutually agree upon, and augment the various vocational clubs that are already present in the district.

Much more work can be done in the integration of the laboratory with the recently founded college by calling upon the teachers and student trainees of that school to assist in the program. To achieve these goals we strongly recommend that the laboratory program director be relieved of some of his classroom duties so that he can use the same creative talent and experience demonstrated throughout this excellent program to build into it even greater capabilities for the science program of the district.

D. Analysis of Project Level Relevance Number

1. Introduction

The Project Level of the network consisted of a set of 99 student projects conducted under the Secondary Program of the MSL. The educational value accrued to the students by conducting these projects in the environment offered by the MSL was assessed in terms of their performance based on:

1. The best use of time.
2. Flexibility in coping with situations beyond the students control.
3. Organization of the study approach.
4. Production of meaningful results and conclusions.
5. Use of supplemental resources (students only).
6. Educational value.

A committee of 12 educators and 12 groups of four students each independently assigned weights to the above criteria and relevance numbers to the student projects.

2. Criteria

The criteria were selected to enable comparison of projects to each other. They are a measure of enhancement of student capability from participation in the MSL. By comparing projects to each other rather than an absolute scale, evaluation of the relative impact of the MSL can be made. Following the standard procedure of comparing students who use the MSL to a control group who had not was not possible. No control group was established during the program since this would have been of little value as the MSL group was exposed to many more factors than could be used for the control group. Measuring progress from one student group to another, both of which had been through the MSL developed as the logical solution.

The weights assess the importance of the criteria in evaluating the projects. Criteria may be added or deleted at any time during the assignment session. In this fashion a complete relevant set of judgment factors is created.

The average criteria weight for both educators and students are shown below.

	EDUCATOR AVERAGE WEIGHTS	STUDENT AVERAGE WEIGHTS	
		Original	Normalized
1. Best Use of Time.	.171	.154	.171
2. Flexibility in coping the students control	.130	.118	.131
3. Organization of the Study Approach	.282	.214	.237
4. Producing meaningful Results and Conclusions	.265	.218	.242
5. Effective Use of Supplemental Resources		.109	
6. Educational Value	.152	.198	.219

Criterion 5, supplemental resources, was not used by the educators in assigning weights. The group felt that the criterion was not important to their assessment. The student relevance reflects the redistribution of their assessment of Criteria 5 to the other criteria for the purposes of making a comparison of weights. Student relevance rankings, of course, include the criterion.

The above results show that on the average students and educators agreed on the weight of criterion 1 and 2. They disagreed widely on criteria 6 and 3, and were fairly close on 4.

However, the data that lies behind the average figures shows clearly the meaning of the criteria.

For the educators, it is notable that there was the least disagreement in the values for criterion 3, the most important, and criterion 2, the least important to the decision. Criterion 3, organization of the study approach was judged to be the most important because it measured the whole of the project. The study approach entailed planning, implementation and analyzing. This criterion compared the projects on the degree to which these three parts of the project were completed. From this, one may infer that to educators, the most important feature of the secondary MSL program is the experience gained in working out an orderly approach to a problem. Every educator on the committee gave this criterion a weight of .25 or .30 with the average being .282.

In contrast, every educator gave criterion 2, flexibility in coping with situations beyond the students control, either .10 or .15 with the average being .130. This criterion measured the adaptability of the student in readjusting his plans and his project to the unexpected. Adaptability, one may infer, is the least important feature to be gained from the MSL experience.

On criterion 4, production of meaningful results and conclusions, the educators were in fair agreement. Most gave it .25 or .30, but two felt that it should be .20 and one, .35. These two extreme positions represented disagreement about the objectives which one pursues in educating. One would stress the methods and ways of attacking a problem and the other would stress reaching conclusions about the problem. The average was .265.

On criterion 1, best use of time, the educators were again in relative agreement. Most gave the criterion .10, .15, or .20

but one felt the value should be .25 and one, .30. This criterion judged what might have been done on this project against what was actually done. The determination of what might have been done was made in the student's terms. The extreme position on this criterion felt that the development of the best possible project was the overriding factor in evaluation projects.

The educators disagreed most in criterion 6, educational value. The weight varied from .00 to .25 with the average being .152. The extreme positions represented disagreement about assessing the applicability of measuring future benefits to the student from his MSL experience. One position believed that future benefits were irrelevant to evaluating student projects. The other felt that some projects would have more future benefits than others and that this fact was highly relevant to evaluating the MSL experience.

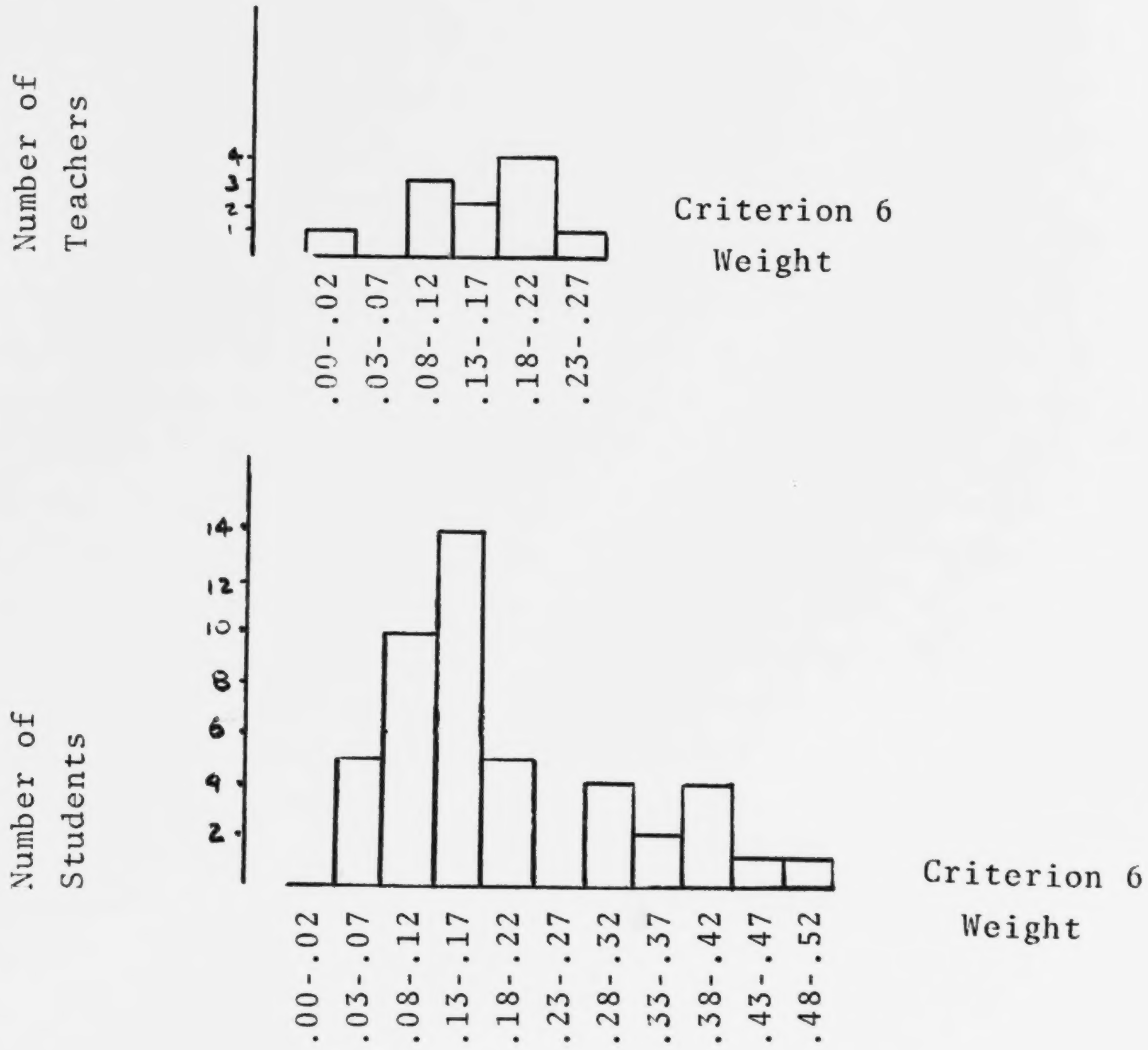
The educators assigned criterion weights in one group of 12. Students assigned weights separately in 12 groups. This means that one would expect more disagreement in the student results. This in fact is the case.

The students' results, however, paralleled to a degree the educators' results. On all criteria except 6, the students were in fair agreement, that is, the ranges were within statistically acceptable bounds. In those five criteria, there were in general a few at the very high end of the scale and a few at the very low end with the majority of assignments concentrated near the averages. The students agreed with the educators that adaptability was the least important benefit to be gained from the MSL program. It is interesting to note that the students felt that reaching meaningful conclusions was more important, although only slightly, than experience in approaching a project. This, one may infer, indicates that educators and students are not in complete concurrence on what educational objectives should be.

Developing the best possible project was the same weight by both educators and students.

This leads us to criterion 6, educational value. The student distribution of weights clearly separated into two parts. One set of 12 students gave the criterion the very high average weight of .37. The other set of 35 students gave it a low average weight of .13. One-fourth of the students felt that the future benefits gained from doing the projects were the most important consideration. It appears that students and educators alike had difficulty in reaching an agreed position on this criterion.

Distributions of Teacher and Student Criterion 6 Weight



Nine of the educators on the evaluation committee conducted the student assignment sessions. It is interesting to note that, while some of the educator criteria rankings had very high correlation with that of the student group, they concluded the average correlation was .69 which is below the threshold of significance of 5%. The correlations ranged from .15 to .975 (1.00 would mean perfect match). This demonstrates that the educators did not bias student criteria weight assignment.

For more details on the criteria see section VI. C.3.

3. Project Relevance

The relevance number is a measure of the educational content of one project with respect to the others. Both educators and students ranked the 99 projects. There was a rank correlation of .76 which is significant at the 1% level. A partial correlation was calculated for the first, middle and last thirds of the list. This yielded correlations of .83, .71 and .73 respectively which are also significant at the 1% level. This demonstrates that students and teachers had the same basic understanding of the criteria by which projects were measured. One may infer also that it was easier to rank the better projects and that the poorer projects were slightly easier to rank than those in the middle of the sample. The relevance rankings were from highest relevance to lowest.

Analysis of the relevance at the Project Level involved determination of the relationships of project relevance on two parameters: student grade level and student project phase.

The relevance by grade level yielded the average relevance per project shown below where a distinct trend of increased relevance exists toward the higher grade.

GRADE	AVERAGE RELEVANCE
7	.0059
8	.0088
9	.0109
10	.0197
11	.0255

The greatest increase in average relevance may be seen between the ninth and tenth grades. This is undoubtedly due to the maturing of the student in his awareness of science and to his increased preparation in science. The results below show an equally meaningful interval between the 7th and 8th grade.

GRADE	MEAN DECILE
7	7.5
8	5.5
9	4.
10	2.
11	1.

The mean decile is the average group of ten into which the weighted average of the project ranks falls, e.g., 1 means in the first ten, 2 in the second ten, etc.

Student grade level had an impact on the relevance his project received. However, it should be noted that the highest ranked project was a group project done by two 10th and 11th graders. The highest individual project was done by a 10th grader. The highest and lowest ranked projects by grade are shown below:

HIGHEST FOR GRADE	RANK (99 Lowest)
7	31
8	15
9	8
10	2
11	5

LOWEST FOR GRADE	RANK (99 Lowest)
7	99
8	91
9	88
10	59
11	5

The highest seventh grade project was higher than about one-half the ninth grade projects, and it was higher than one 10th grade project.

Project relevance by student phase (Basic, Phase I, II, and III) yielded the average relevance per project shown below.

GROUP	AVERAGE RELEVANCE
Basic	.0063
I	.0075
II	.0094
III	.0170

Again the results show that student ability to plan, to collect samples and to analyze data improves with increase student participation in the MSL program. It is significant to educators working for better methods of implementing the learning process that immediate and continued improvement occurs for students using the MSL. The highest seven projects were all done by Phase III students and the lowest seven were all by Basic Phase students.

The highest and lowest ranked project from each phase are shown below:

HIGHEST FOR GROUP	RANK (99 Lowest)
Basic	13
I	21
II	8
III	1
LOWEST FOR GROUP	RANK (99 Lowest)
Basic	99
I	91
II	88
III	59

The highest project from the Basic Phase was done by a ninth grader, ranking thirteenth in the list. This shows MSL program potential for early achievement as well as for progressive improvement.

Combining and comparing the data for grade and for phase yielded the results below:

GRADE	PHASE	AVERAGE RELEVANCE
8	I	.0075
	II	.0129
	III	.0099
9	I	.0080
	II	.0116
	III	.0128

The only available data occurred for eighth and ninth graders. Seventh graders did only Basic Phase project and tenth graders did only Phase III projects.

The trend in the table is that of progressive improvement toward the upper phases. The one exception consisted of the one Phase III eighth grade project included for completeness. The results in this table certainly confirm the benefit to the students of participation in the MSL program.

4. Conclusions

The evaluation found that the most important thing to be gained from the MSL is exposure to ways of attacking and solving problems. Production of meaningful results and conclusions was also found to be important. On this basis it is clear from the relevance analysis that the MSL secondary program had a significiant learning impact on the students who participated in it.

All the data showed that students who had progressed through the four phases of the program were measurably effected by their experience. Although grade level correlated strongly with benefits, the comparison of eighth and ninth graders showed that benefits from participation in the MSL program increased for every year the student was in the program.

The value of the MSL is confirmed by these results. Comparison of similar groups with similar backgrounds differentiated principally by more exposure to the MSL presents conclusive evidence of the MSL impact on increasing educational benefits to the students through working on projects.

E. Analysis of Means Level Relevance Numbers

1. Introduction

The Means Level of the network consisted of the three phases of each student project. The educational value to the students of planning, implementing and analyzing in their projects through use of the MSL program was assessed in terms of:

1. Organization of thoughts and ideas.
2. Collection and development of sufficient data.
3. Completion of the three phases of the problem, as defined by the students.
4. Fulfillment of phase expectations.
5. Effective use of the MSL program (teachers only).

A committee of 12 educators and 12 groups of four students each independently assigned weights to the above criteria and relevance numbers to the student projects.

2. Criteria

The criteria were selected to enable comparison of the project phases to each other. They are a measure of the enhancement of student skills in planning a project, collecting data, and reaching a conclusion. Comparing the phases to each other will apprise the student of his relative strengths and weaknesses in conducting a science project. The weights assess the importance of the criteria. The criteria represent the complete set of factors on which to measure the three parts of each project.

The average criteria weights for both educators and students are shown below:

	EDUCATOR AVERAGE WEIGHTS		STUDENT AVERAGE WEIGHTS
	Original	Normalized	
1. Organization of Thoughts and Ideas	.233	.280	.330
2. Collection and Development of Sufficient Data	.156	.308	.307
3. Completion of Each Phase Objective	.182	.219	.179
4. Fulfillment of Project	.160	.193	.184
5. Use of MSL Resources	.169	*	*

*Criterion 5, use of MSL resources, was not used by students in assigning criteria weights. This criterion was added by the educators who wanted to relate the applicability of doing project sections in the MSL. To allow comparison, the weight of criterion 5 was distributed to the other criteria. Educator relevance rankings include the criterion.

The above results show that on the average educators and students agreed on the weight for criterion 2. They were in wide disagreement on criteria 1 and 3, and were fairly close in 4. The data behind these average values clearly shows the meaning the criteria convey.

Educators judged criteria 1 and 2 most important in measuring student achievement. Criterion 2, collection of sufficient data, was given .256, the highest average weight. Educators did not reach close agreement on this criterion. Most assigned a weight from .20 to .30, but two gave it .35 and one .15. These extremes represented differences in emphasis in collection. The one position stresses learning ways of collecting data, planning the collection and implementing it to a sufficient degree to make an analysis. The other would stress methodology, irrespective of data.

Criterion 1, organizing thoughts and ideas, was ranked second to criterion 2 by most educators. It was assigned an average weight of .233. This criterion assessed the degree to which the student developed a plan of action and stated an analytic methodology. Four educators ranked this equal to criterion 2. Two ranked it first, while three ranked criterion 2 first. There was again a wide range on weights, .15 to .30 with most educators assigning .20 or .25. The extremes again reflect the difference between stating a methodology and collecting data.

Criterion 3, completion of each phase objective, evoked substantial disagreement. Two educators weighed this .30, while the rest gave it .10 to .20. The extreme here reflected the belief that finishing something deserves significant consideration in determining program benefits to students. The average weight was .182.

Criterion 5, use of the MSL, split the group in two parts. One felt that .10 to .15 was the appropriate weight, while the other felt that .20 to .25 was most relevant. This criterion measured student necessity to use MSL for his project. It measured the degree of creativity for the student in conceiving his project as something that could not be done at home.

The students were in closest agreement with each other on criterion 2, collection of data, which they ranked second with an average weight of .307. Student weightings ranged from .10 to .60 with slightly less than half the students giving the criterion a weight greater than .35. This compares with criterion 1, organization of thoughts, which was ranked first with an average weight of .330. Here again slightly less than half the students gave the criterion a weight greater than .35, while the range was from .10 to .15. These figures reflect the division among students, similar to that among educators, as to the necessity for creating a methodology or for collecting data on which to operate. In any case, both students and educators believe that developing a methodology and collecting data are by far the most important items to consider in designing and implementing a project.

The students found fair agreement in the weight of criterion 3, completion of phase objectives, assigning an average value of .179, the lowest of the criterion weights for students. They felt that finishing the phase was not really as important as its organization.

Criterion 4, fulfillment of project expectations, was assigned average weight of .184. Some students weighed this as high as .40, but more than three quarters weighed it below .20. Students felt that fulfillment of the goals they had set for themselves was slightly more important than those set by the project. Educators felt the opposite, ranking self-set goals substantially lower than project-set goals.

The educator and student criteria weight average rank correlation was .52, well below the threshold of significance of 5%. This again shows that educators had no influence on the assignment of criterion weight by students in the group the educator monitored.

For more details on the criteria see section VI. C.3.

3. PIA Relevance

The relevance number is a measure of the accomplishment in one phase of the student project against the others. Both educators and student assigned relevance at the PIA level. The ranked listings were from highest to lowest relevance.

Analysis of the relevance numbers at the Means Level involved determination of the relationship of planning, implementation and analysis relevance on two parameters: student grade level and student project phase. A comparison of project phase relation to grade level was also made.

The average relevance by grade level yielded the average relevance per PIA means per project as shown below:

GRADE	AVERAGE RELEVANCE		
	P	I	A
7	.0026	.0021	.0011
8	.0044	.0025	.0018
9	.0049	.0038	.0025
10	.0072	.0067	.0054
11	.0082	.0078	.0083
Groups	.0041	.0020	.0021

These results indicate that higher grade levels on the average recieve higher relevances. The eighth and ninth grades received slightly higher scores than did the group projects (which combined students from several grades). The seventh grade was lowest in the planning and the analysis sections, and was about the same as the group projects in the implementation phase. The tenth and eleventh grades received the most relevance in all three of the project sections.

The results also indicate that, in general, planning received higher relevance followed by implementation and finally analysis. This indicates that on the average students are planning their projects better than they are collecting or analyzing data. The following shows the highest ranked and lowest ranked project section by grade level.

HIGHEST FOR GRADE	RANK (298 Lowest)		
	P	I	A
7	48	80	159
8	41	45	88
9	12	23	33
10	5	3	8

LOWEST FOR GRADE	RANK (298 Lowest)		
	P	I	A
7	298	289	297
8	212	268	286
9	168	290	292
10	119	173	188

The same sequence of planning followed by implementation and analysis is evident. The grade level of the student had an impact on the relevance in each category.

The average relevance for planning, implementation and analysis by student phase is shown below.

PHASE	AVERAGE RELEVANCE		
	P	I	A
Basic	.0027	.0022	.0012
I	.0039	.0020	.0014
II	.0045	.0030	.0019
III	.0061	.0058	.0047

The more advanced students in the MSL program receive the higher relevances. The differential is not as great as for grade level, but the evidence is present in every category. It is interesting to note that in implementation and analysis, only Phase III shows a substantial difference from the other student phases. Planning shows a much more differentiated range. Again, the categories are ordered from planning to implementation to analysis.

Extracting the highest and lowest rank in each student phase for planning, implementation and analysis yields.

HIGHEST IN GROUP	RANK (298 Lowest)		
	P	I	A
Basic	40	31	159
I	32	64	107
II	10	23	33
III	1	2	4

LOWEST IN GROUP	RANK (298 Lowest)		
	P	I	A
Basic	298	289	297
I	212	268	295
II	182	290	296
III	119	250	210

These results verify the trend toward higher relevance from Basic to Phase III in relevance rank. The most striking thing that is to be found in the "Highest in Group" section is the fact that the highest Basic Phase project was ranked higher in the implementation section than was that from Phase I. This seeming discrepancy is explained by the fact that this project was done by a tenth grader.

Cross-tabulating grade level and project phase yields the results shown below. Again the seventh and tenth grades have not been included because of their concentration in one phase.

GRADE	PHASE	AVERAGE RELEVANCE		
		P	I	A
8	I	.0039	.0019	.0014
	II	.0049	.0036	.0025
	III	.0045	.0026	.0026
9	I	.0031	.0029	.0018
	II	.0048	.0033	.0021
	III	.0051	.0044	.0031

The results in this table show that the MSL program had a significant effect in each category of the student project. The relevance in every case strongly emphasizes the fact that the MSL enhanced student capabilities between Phase I and Phase III. The differences between Phase II and III in the eight grade is likely due in fact to the small sample size as was mentioned in the project analysis. Also the ranking of planning followed by implementation and anlaysis holds for this cross-tabulation.

The MSL had significant impact on the secondary student in enabling him to better prepare a project. The planning section received higher relevance than the implementation or the analysis section for almost every student. Cross-tabulation between grade level and project phase showed that the projects in Phase III received more relevance than those in Phase I.

The data shows that the analysis and the implementation sections improved in relation to the planning section. Students started in the program developing the planning phase by far the best. After four years in the MSL program, understanding of the analytic and collection methods increased making the overall project much better balanced in Phase III.

4. Conclusions

The evaluation found that the most important factors in determining student strengths and weaknesses in conducting a science project are the creation of a methodology and a plan of action and collection of sufficient data with which to work. Students and educators both agreed that these were the key factors.

It is clear from the data that longer exposure to the MSL yields increased benefits to students. While the data showed that grade level correlated strongly with relevance, the cross-tabulation of grade level and project phase strongly demonstrated that benefits from the MSL program increased every year. These results are strengthened by the fact that in each project section relevance increased from the Basic Phase to Phase III, with grade level held constant.

The data also indicates that although students were better able to plan than to implement and to analyze, those students who had progressed through all four phases of the MSL were able to develop a more balanced science project in terms of accomplishment in each of the project sections. The students were better able to develop a methodology for each project section and were better able to collect the required data.

The value of the Mobile Science Laboratory for science education is confirmed by these results. Comparison of some grade level students with similar backgrounds differentiated principally by more exposure to the MSL presents conclusive evidence of MSL application in providing expanded science education benefits.

F. Sample of Computer Listings

This section includes a basic set of computer runs used in the analysis. Due to the extensive volume of computer output listings, the entire array of runs cannot be included in this report. However, a complete copy of computer listings was provided to the Project Director.

Figure VII-1 is the educator ranked relevance number listing of the program level. The left-most column is the rank numbers (0001-0010) followed by the option IDs, the option titles and the branch relevances.

Figure VII-2 is the educator ranked relevance number listing of the function level. The left-most column is the rank numbers (0001-0004) followed by the option IDs, the option titles and branch relevances.

Figure VII-3 is the educator ranked relevance number listing of the project level. The listing is composed of the ranking (0001-0099) in the left-most column followed by the option IDs, titles and branch relevance respectively.

Figure VII-4 is the student ranked relevance number listing of the project level. The listing is composed of the rankings (0001-0099) in the left-most column followed by the option IDs, titles and branch relevance respectively.

Figure VII -5 is the educator ranked relevance listing (first 25 and last 25) of the planning, implementation and analysis level. The listing is composed of the rankings (0001-00025... 0270-0294) in the left-most column followed by the option IDs, titles and branch relevance respectively.

Figure VII-6 is the student ranked relevance listing (first 25 and last 25) of the planning, implementation and analysis level. The listing is composed of the rankings (0001-0025... 0270-0294) in the left-most column followed by the option IDs, titles and branch relevance respectively.

```
          TOTAL DIRECT RELEVANCE OF THE PROGRAM
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                            TITLE                                    RELEVANCE

0001 1A01               MOBILE SCIENCE LABORATORY                                0.1615763
0002 1A03               FLOATING SCIENCE LABORATORY                              0.1282261
0003 1A04               SCIENCE ENRICHMENT STATION                               0.1119502
0004 1A06               OUTDOOR SEMI-MOBILE PROGRAM                              0.1057928
0005 1A05               VARIED VISITATION PROGRAM                                0.0993836
0006 1A02               FOREST SCIENCE LABORATORY                                0.0837502
0007 1A07               SCIENCE STUDY STATION                                    0.0796145
0008 1A08               NATURE CLASSROOM                                         0.0776097
0009 1A10               CAMPING EXPERIMENT PROGRAM                               0.0765058
0010 1A09               SITE VISITATION SCIENCE PROGRAM                          0.0755908
```

Figure VII - 1 Educator Branch Relevance Listing of the Program Level

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          TOTAL DIRECT RELEVANCE OF THE FUNCTION
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                            TITLE                                   RELEVANCE

0001 1A01F1                 ELEMENTARY USES                                     0.0604154
0002 1A01F2                 SECONDARY USES                                      0.0539518
0003 1A01F3                 TEACHER USES                                        0.0323567
0004 1A01F4                 COMMUNITY USES                                      0.0148522
```

Figure VII - 2 Educator Branch Relevance Listing of the Function Level

```
          TOTAL DIRECT RELEVANCE OF THE PROJECTS
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK       ID                              TITLE                                    RELEVANCE

0001 1A01F2304433         COMP TWO N.MINN FOREST COMMUNITIES              0.0337249
0002 1A01F2304427         SOIL RELATION TO VEGATION                       0.0310891
0003 1A01F2302417         COMP SML MAMMAL BURNED + UNBURNED AREA          0.0285868
0004 1A01F2305401         EFFECT ENVIR HEART LILLY, FLOWR OR PLNT         0.0260852
0005 1A01F2304408         COMP DECAY INSECTS BURNED+UNBURNED PINE         0.0255741
0006 1A01F2302403         MOVEMENT HABITS OF MICE                         0.0238493
0007 1A01F2307406         COMPARISON OF TWO PLANT SAMPLING TECH           0.0232499
0008 1A01F2303317         COMPARISON TWO FOREST AREAS                     0.0227252
0009 1A01F2302313         INSECTS OF ITASCA PARK                          0.0184566
0010 1A01F2305419         GROWTH RATE OF WILD FLOWERS                     0.0182219
0011 1A01F2304407         VEG COMP SECND STRA FLORQ TWO AREAS             0.0177252
0012 1A01F2305415         VEGETATIVE COMP FOREST+BURNED AREA              0.0174888
0013 1A01F2307127         GROWTH RATE  HORSETAIL TWO ENVIRONMENTS         0.0170663
0014 1A01F2306425         WILD FLOWER ECOLOGY                             0.0163562
0015 1A01F2306323         PLANTS IN TWO HABITITATES                       0.0156417
0016 1A01F2305424         PLANT GROWTH                                    0.0154117
0017 1A01F2306328         COMP PLANT LOC FOUR LOGS IN ITASCA              0.0153431
0018 1A01F2305327         RELATIONSHIP SOIL AND VEGETATION                0.0146518
0019 1A01F2303438         COMP LND+WTR PLANTS + SOILS                     0.0131600
0020 1A01F2108410         LOC COND+RELSHIPS IGNEOUS ROCKS                 0.0129327
0021 1A01F2306232         DISEASE OF HARDWOOD MAPLES                      0.0128098
0022 1A01F2305418         PLANT ECOLOGY VERUS ENVIRONMENT                 0.0124065
0023 1A01F2209239         FIVE PHASES GENERAL ASTRONOMY                   0.0123400
0024 1A01F2306434         COMBINATION WILD FLOWER GROWTH + POP            0.0123254
0025 1A01F2303213         LIVING THINGS IN A DROP OF WATER                0.0122967
0026 1A01F2303329         PLANTS+ANIMALS LAND,WATER,AIR MEET              0.0122422
0027 1A01F2108308         ROCK TYPES OF SQ LAKE COMP                      0.0119796
0028 1A01F2301414         FISH NEEDED FOOD                                0.0119025
0029 1A01F2302311         CASTING LARGE MAMMAL TRACKS                     0.0118573
0030 1A01F2112402         SOIL COMPARISON                                 0.0117639
0031 1A01F2307110         WOODLAND FUNGI                                  0.0117455
0032 1A01F2108421         LAND FORMATION-STUDY OF                         0.0113333
0033 1A01F2301412         FISH ECOLOGY                                    0.0106670
0034 1A01F2307112         WILD FLOWERS                                    0.0105540
0035 1A01F2112302         LAKE SEDIMENTS                                  0.0103392
0036 1A01F2305319         RELATION PLANT-SOIL TYPE + TERRAIN              0.0102011
```

Figure VII - 3 Educator Branch Relevance Listing of the Project Level (1 of 3)

```
          TOTAL DIRECT RELEVANCE OF THE PROJECTS
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                              TITLE                                        RELEVANCE

0037 1A01F2304404          COMP OF TREES IN DIFFERENT AREAS                     0.0098421
0038 1A01F2303411          OBSERVING + CULTIVATING ALGAE                        0.0096538
0039 1A01F2110116          FOSSILS IN IMMEDIATE AREA                            0.0093163
0040 1A01F2307124          WOODLAND FERNS                                       0.0091715
0041 1A01F2110112          FOSSILS                                              0.0091641
0042 1A01F2306118          EDIBLE PLANTS                                        0.0090927
0043 1A01F2301122          FISH OF S. MINN + N. IOWA                            0.0090822
0044 1A01F2302322          SIM+DIF NESTING BIRDS IN SQLKE+ITASCA                0.0090213
0045 1A01F2209336          RELATIONSHIP-TEMP,WIND+WEATHER                       0.0089650
0046 1A01F2302312          ANTS AND THEIR SURVIVAL                              0.0089436
0047 1A01F2303221          AQUATIC PLANTS                                       0.0088295
0048 1A01F2304310          PHOTO+CLASS TREES ITASCA PARK                        0.0087392
0049 1A01F2108224          THE STUDY OF SAND FORMS IN S.E. MINN                 0.0087352
0050 1A01F2301103          SML FISH IN S. MINN                                  0.0087078
0051 1A01F2301110          SMALL FISH IN S. MINN                                0.0086595
0052 1A01F2209340          HEAT VARIATION LAND,WATER,AIR                        0.0086100
0053 1A01F2305231          STUDY OF PLANTS IN SAND PRARIE                       0.0085891
0054 1A01F2301131          FISH                                                 0.0085806
0055 1A01F2112330          MAP ELEVATION SQUAW LAKE AREA                        0.0083126
0056 1A01F2302113          BUTTERFLIES                                          0.0081517
0057 1A01F2112235          WATER AND SOIL CONSERVATION                          0.0080178
0058 1A01F2209413          FOUR PHASES OF GENERAL ASTRONOMY                     0.0080000
0059 1A01F2302405          PHYSICAL ENVIR ON PERS SENSITIVITY                   0.0079816
0060 1A01F2112115          SOIL TYPING                                          0.0075695
0061 1A01F2108337          ROCK COLLECTING                                      0.0074386
0062 1A01F2307104          WEEDS                                                0.0074123
0063 1A01F2110101          FOSSIL STUDY                                         0.0072373
0064 1A01F2110202          FOSSILS AND THEIR TIME PERIOD                        0.0070881
0065 1A01F2303341          OBS AQUATIC PLANTS IN SQUAW LAKE                     0.0070776
0066 1A01F2110108          SOUTHERN MINN FOSSILS                                0.0067848
0067 1A01F2305241          VEGETATIVE STUDY N+S SLOPE WHITEWATER                0.0065433
0068 1A01F2112122          SOIL TYPES                                           0.0060426
0069 1A01F2112106          SOIL TYPING                                          0.0059870
0070 1A01F2110242          FOSSILIFEROUS ROCK UNITS OF MINN                     0.0056806
0071 1A01F2302333          MOTHS OF ITASCA STATE PARK                           0.0055513
0072 1A01F2209214          PHOTO PLANETS AND STARS                              0.0054475
```

Figure VII - 3 Educator Branch Relevance Listing of the Project Level (2 of 3)

```
               TOTAL DIRECT RELEVANCE OF THE PROJECTS
          RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK       ID                              TITLE                                              RELEVANCE

0073 1A01F2304339          DECIDUOUS TREES OF ITASCA PARK                        0.0054364
0074 1A01F2112109          SOIL TYPES SM + N IOWA                                0.0053437
0075 1A01F2303217          PLNTS DIF HEIGHTS + DISTANCES FROM WATER              0.0052479
0076 1A01F2112338          COMP OF SOILS SQUAW LAKE BOTTOM                       0.0048722
0077 1A01F2108204          RECOGNIZING DIFFERENT MINERALS                        0.0048022
0078 1A01F2304309          TREE STUDY IN ITASCA                                  0.0046684
0079 1A01F2108316          LANDSCAPE OF ITASCA PARK                              0.0045432
0080 1A01F2112334          GLACIAL TILL OF A RIDGE + VALLEY                      0.0041432
0081 1A01F2111115          FOSSILS                                               0.0038548
0082 1A01F2111120          FOSSILS                                               0.0038179
0083 1A01F2108331          ELEVATION OF SQUAW LAKE                               0.0037360
0084 1A01F2112111          ROCK AND FOSSIL COLLECTION                            0.0035076
0085 1A01F2111114          FOSSILS                                               0.0034638
0086 1A01F2111126          SEA FOSSILS                                           0.0034408
0087 1A01F2111105          FOSSILS                                               0.0034270
0088 1A01F2108325          CONTOUR MAP OF SQUAW LAKE                             0.0034193
0089 1A01F2209205          PHOTOGRAPHY OF PLANTES AND STARS                      0.0033937
0090 1A01F2111104          COLLECT FOSSILS                                       0.0033763
0091 1A01F2303201          PHOTOMICROGRAPHY OF ACQUATIC LIFE                     0.0033207
0092 1A01F2303133          WATER SAMPLES                                         0.0033030
0093 1A01F2209107          THE MOON                                              0.0032437
0094 1A01F2111102          FOSSILS IN SM + NI                                    0.0031234
0095 1A01F2111117          PALEONTOLOGY                                          0.0030958
0096 1A01F2303107          SOUTHERN MINN WATERS                                  0.0029428
0097 1A01F2108109          COLLECTION OF ROCKS IN MINN                           0.0027748
0098 1A01F2108106          ROCKS IN GENERAL                                      0.0023640
0099 1A01F2108118          ROCKS IN MINN + OTHER STATES                          0.0018405
```

Figure VII - 3 Educator Branch Relevance Listing of the Project Level (3 of 3)

```
          TOTAL DIRECT RELEVANCE OF THE PROJECTS
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK       ID                               TITLE                                          RELEVANCE

0001 1A01F2304433          COMP TWO N.MINN FOREST COMMUNITIES                          0.0288487
0002 1A01F2304408          COMP DECAY INSECTS BURNED+UNBURNED PINE                     0.0287229
0003 1A01F2302417          COMP SML MAMMAL BURNED + UNBURNED AREA                      0.0258002
0004 1A01F2305415          VEGETATIVE COMP FOREST+BURNED AREA                          0.0248025
0005 1A01F2301412          FISH ECOLOGY                                                0.0228205
0006 1A01F2306328          COMP PLANT LOC FOUR LOGS IN ITASCA                          0.0228066
0007 1A01F2307406          COMPARISON OF TWO PLANT SAMPLING TECH                       0.0213193
0008 1A01F2304427          SOIL RELATION TO VEGATION                                   0.0200780
0009 1A01F2305401          EFFECT ENVIR HEART LILLY, FLOWR OR PLNT                     0.0197552
0010 1A01F2304310          PHOTO+CLASS TREES ITASCA PARK                               0.0190685
0011 1A01F2305418          PLANT ECOLOGY VERUS ENVIRONMENT                             0.0189871
0012 1A01F2301414          FISH NEEDED FOOD                                            0.0179302
0013 1A01F2306232          DISEASE OF HARDWOOD MAPLES                                  0.0163549
0014 1A01F2302403          MOVEMENT HABITS OF MICE                                     0.0161919
0015 1A01F2305231          STUDY OF PLANTS IN SAND PRARIE                              0.0154159
0016 1A01F2302311          CASTING LARGE MAMMAL TRACKS                                 0.0148595
0017 1A01F2305327          RELATIONSHIP SOIL AND VEGETATION                            0.0142828
0018 1A01F2305419          GROWTH RATE OF WILD FLOWERS                                 0.0142652
0019 1A01F2307127          GROWTH RATE  HORSETAIL TWO ENVIRONMENTS                     0.0142241
0020 1A01F2302312          ANTS AND THEIR SURVIVAL                                     0.0140826
0021 1A01F2209239          FIVE PHASES GENERAL ASTRONOMY                               0.0133562
0022 1A01F2307124          WOODLAND FERNS                                              0.0123876
0023 1A01F2304404          COMP OF TREES IN DIFFERENT AREAS                            0.0123111
0024 1A01F2306323          PLANTS IN TWO HABITITATES                                   0.0121930
0025 1A01F2303329          PLANTS+ANIMALS LAND,WATER,AIR MEET                          0.0120445
0026 1A01F2307110          WOODLAND FUNGI                                              0.0119300
0027 1A01F2112402          SOIL COMPARISON                                             0.0119067
0028 1A01F2302313          INSECTS OF ITASCA PARK                                      0.0118499
0029 1A01F2306425          WILD FLOWER ECOLOGY                                         0.0118420
0030 1A01F2302333          MOTHS OF ITASCA STATE PARK                                  0.0117134
0031 1A01F2302405          PHYSICAL ENVIR ON PERS SENSITIVITY                          0.0116256
0032 1A01F2303317          COMPARISON TWO FOREST AREAS                                 0.0114071
0033 1A01F2305319          RELATION PLANT-SOIL TYPE + TERRAIN                          0.0112636
0034 1A01F2307112          WILD FLOWERS                                                0.0112372
0035 1A01F2112235          WATER AND SOIL CONSERVATION                                 0.0112346
0036 1A01F2111115          FOSSILS                                                     0.0111235
```

Figure VII - 4 Student Branch Relevance Listing of the Project Level   (1 of 3)

```
          TOTAL DIRECT RELEVANCE OF THE PROJECTS
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                                  TITLE                                       RELEVANCE

0037 1A01F2303438        COMP LND+WTR PLANTS + SOILS                                      0.0107410
0038 1A01F2304407        VEG COMP SECND STRA FLORQ TWO AREAS                              0.0103877
0039 1A01F2306434        COMBINATION WILD FLOWER GROWTH + POP                             0.0103043
0040 1A01F2303221        AQUATIC PLANTS                                                   0.0102892
0041 1A01F2306118        EDIBLE PLANTS                                                    0.0101121
0042 1A01F2112302        LAKE SEDIMENTS                                                   0.0100563
0043 1A01F2303341        OBS AQUATIC PLANTS IN SQUAW LAKE                                 0.0096242
0044 1A01F2303411        OBSERVING + CULTIVATING ALGAE                                    0.0093797
0045 1A01F2304339        DECIDUOUS TREES OF ITASCA PARK                                   0.0092644
0046 1A01F2303213        LIVING THINGS IN A DROP OF WATER                                 0.0092055
0047 1A01F2209336        RELATIONSHIP-TEMP,WIND+WEATHER                                   0.0091594
0048 1A01F2302322        SIM+DIF NESTING BIRDS IN SQLKE+ITASCA                            0.0090770
0049 1A01F2303201        PHOTOMICROGRAPHY OF ACQUATIC LIFE                                0.0088299
0050 1A01F2305424        PLANT GROWTH                                                     0.0085171
0051 1A01F2209340        HEAT VARIATION LAND,WATER,AIR                                    0.0084535
0052 1A01F2108106        ROCKS IN GENERAL                                                 0.0081226
0053 1A01F2304309        TREE STUDY IN ITASCA                                             0.0081183
0054 1A01F2307104        WEEDS                                                            0.0081015
0055 1A01F2303217        PLNTS DIF HEIGHTS + DISTANCES FROM WATER                         0.0080374
0056 1A01F2110112        FOSSILS                                                          0.0077607
0057 1A01F2110116        FOSSILS IN IMMEDIATE AREA                                        0.0077418
0058 1A01F2108410        LOC COND+RELSHIPS IGNEOUS ROCKS                                  0.0076526
0059 1A01F2108308        ROCK TYPES OF SQ LAKE COMP                                       0.0076459
0060 1A01F2303133        WATER SAMPLES                                                    0.0076316
0061 1A01F2108109        COLLECTION OF ROCKS IN MINN                                      0.0076102
0062 1A01F2110202        FOSSILS AND THEIR TIME PERIOD                                    0.0076026
0063 1A01F2112330        MAP ELEVATION SQUAW LAKE AREA                                    0.0075770
0064 1A01F2108421        LAND FORMATION-STUDY OF                                          0.0074911
0065 1A01F2108204        RECOGNIZING DIFFERENT MINERALS                                   0.0073209
0066 1A01F2302113        BUTTERFLIES                                                      0.0071994
0067 1A01F2110242        FOSSILIFEROUS ROCK UNITS OF MINN                                 0.0067993
0068 1A01F2112106        SOIL TYPING                                                      0.0067139
0069 1A01F2110101        FOSSIL STUDY                                                     0.0066412
0070 1A01F2108118        ROCKS IN MINN + OTHER STATES                                     0.0066260
0071 1A01F2108325        CONTOUR MAP OF SQUAW LAKE                                        0.0064288
0072 1A01F2110108        SOUTHERN MINN FOSSILS                                            0.0058569
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Figure VII - 4 Student Branch Relevance Listing of the Project Level (2 of 3)

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           TOTAL DIRECT RELEVANCE OF THE PROJECTS
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                              TITLE                                    RELEVANCE

0073 1A01F2209205         PHOTOGRAPHY OF PLANTES AND STARS                         0.0057142
0074 1A01F2112334         GLACIAL TILL OF A RIDGE + VALLEY                         0.0054475
0075 1A01F2108316         LANDSCAPE OF ITASCA PARK                                 0.0053564
0076 1A01F2301122         FISH OF S. MINN + N. IOWA                                0.0051338
0077 1A01F2209214         PHOTO PLANETS AND STARS                                  0.0050267
0078 1A01F2112122         SOIL TYPES                                               0.0049268
0079 1A01F2112115         SOIL TYPING                                              0.0049200
0080 1A01F2111120         FOSSILS                                                  0.0048725
0081 1A01F2209413         FOUR PHASES OF GENERAL ASTRONOMY                         0.0047887
0082 1A01F2112109         SOIL TYPES SM + N IOWA                                   0.0047608
0083 1A01F2111114         FOSSILS                                                  0.0047249
0084 1A01F2108331         ELEVATION OF SQUAW LAKE                                  0.0045785
0085 1A01F2112111         ROCK AND FOSSIL COLLECTION                               0.0042413
0086 1A01F2112338         COMP OF SOILS SQUAW LAKE BOTTOM                          0.0041145
0087 1A01F2301103         SML FISH IN S. MINN                                      0.0038481
0088 1A01F2301131         FISH                                                     0.0036770
0089 1A01F2108337         ROCK COLLECTING                                          0.0036683
0090 1A01F2303107         SOUTHERN MINN WATERS                                     0.0036094
0091 1A01F2209107         THE MOON                                                 0.0035008
0092 1A01F2108224         THE STUDY OF SAND FORMS IN S.E. MINN                     0.0033981
0093 1A01F2301110         SMALL FISH IN S. MINN                                    0.0027502
0094 1A01F2305241         VEGETATIVE STUDY N+S SLOPE WHITEWATER                    0.0023102
0095 1A01F2111105         FOSSILS                                                  0.0019096
0096 1A01F2111102         FOSSILS IN SM + NI                                       0.0015367
0097 1A01F2111126         SEA FOSSILS                                              0.0014862
0098 1A01F2111104         COLLECT FOSSILS                                          0.0012631
0099 1A01F2111117         PALEONTOLOGY                                             0.0006831
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Figure VII - 4 Student Branch Relevance Listing of the Project Level (3 of 3)

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             TOTAL DIRECT RELEVANCE OF THE PLAN-IMPL-ANAL
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                                        TITLE                                                      RELEVANCE

0001 1A01F2304433A1          PLANNING                                                                      0.0117278
0002 1A01F2304433B1          IMPLEMENTATION                                                                0.0114664
0003 1A01F2302417B1          IMPLEMENTATION                                                                0.0108343
0004 1A01F2304433C1          ANALYSIS                                                                      0.0105306
0005 1A01F2302417A1          PLANNING                                                                      0.0105020
0006 1A01F2304427A1          PLANNING                                                                      0.0104562
0007 1A01F2304427B1          MPLEMENTATION                                                                 0.0103889
0008 1A01F2304427C1          ANALYSIS                                                                      0.0102438
0009 1A01F2305401A1          PLANNING                                                                      0.0095060
0010 1A01F2306323A1          PLANNING                                                                      0.0092447
0011 1A01F2302403B1          IMPLEMENTATION                                                                0.0092356
0012 1A01F2303317A1          PLANNING                                                                      0.0089335
0013 1A01F2304408C1          ANALYSIS                                                                      0.0087367
0014 1A01F2304408A1          PLANNING                                                                      0.0086376
0015 1A01F2302403A1          PLANNING                                                                      0.0085231
0016 1A01F2305401B1          IMPLEMENTATION                                                                0.0084290
0017 1A01F2304408B1          IMPLEMENTATION                                                                0.0081996
0018 1A01F2305401C1          ANALYSIS                                                                      0.0081501
0019 1A01F2305419A1          PLANNING                                                                      0.0079180
0020 1A01F2307406C1          ANALYSIS                                                                      0.0078584
0021 1A01F2307406A1          PLANNING                                                                      0.0077615
0022 1A01F2307406B1          IMPLEMENTATION                                                                0.0076298
0023 1A01F2303317B1          MPLEMENTATION                                                                 0.0074563
0024 1A01F2302417C1          ANALYSIS                                                                      0.0072503
0025 1A01F2302313A1          PLANNING                                                                      0.0069789
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Figure VII - 5   Educator Branch Relevance Listing of the PIA Level   (1 of 2)

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                 TOTAL DIRECT RELEVANCE OF THE PLAN-IMPL-ANAL
   RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK         ID                          TITLE                                      RELEVANCE
0270  1A01F2108331C1        ANALYSIS                                                  0.0006992
0271  1A01F2305241C1        ANALYSIS                                                  0.0006420
0272  1A01F2209205C1        ANALYSIS                                                  0.0005954
0273  1A01F2111117C1        ANALYSIS                                                  0.0005553
0274  1A01F2108106B1        IMPLEMENTATION                                            0.0005305
0275  1A01F2209107C1        ANALYSIS                                                  0.0005285
0276  1A01F2108109B1        IMPLEMENTATION                                            0.0005119
0277  1A01F2108109C1        ANALYSIS                                                  0.0004810
0278  1A01F2209214C1        ANALYSIS                                                  0.0004439
0279  1A01F2112334C1        ANALYSIS                                                  0.0004272
0280  1A01F2108106C1        ANALYSIS                                                  0.0004231
0281  1A01F2304309C1        ANALYSIS                                                  0.0003929
0282  1A01F2209107B1        IMPLEMENTATION                                            0.0003880
0283  1A01F2303217C1        ANALYSIS                                                  0.0003673
0284  1A01F2304339C1        ANALYSIS                                                  0.0003534
0285  1A01F2304309B1        IMPLEMENTATION                                            0.0003501
0286  1A01F2108118B1        IMPLEMENTATION                                            0.0003090
0287  1A01F2108325B1        IMPLEMENTATION                                            0.0002781
0288  1A01F2303133C1        ANALYSIS                                                  0.0002224
0289  1A01F2108118C1        ANALYSIS                                                  0.0002221
0290  1A01F2108325C1        ANALYSIS                                                  0.0001867
0291  1A01F2303201C1        ANALYSIS                                                  0.0001752
0292  1A01F2302333C1        ANALYSIS                                                  0.0001665
0293  1A01F2303107C1        ANALYSIS                                                  0.0001471
0294  1A01F2303107A1        PLANNING                                                  0.0000000
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Figure VII - 5 Educator Branch Relevance Listing of the PIA Level (2 of 2)

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              TOTAL DIRECT RELEVANCE OF THE PLAN-IMPL-ANAL
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK       ID                                   TITLE                                      RELEVANCE

0001 1A01F2304310A1          PLANNING                                                 0.0141059
0002 1A01F2304433B1          IMPLEMENTATION                                           0.0116614
0003 1A01F2304408A1          PLANNING                                                 0.0103147
0004 1A01F2302333A1          PLANNING                                                 0.0097294
0005 1A01F2305418A1          PLANNING                                                 0.0094935
0006 1A01F2305418B1          IMPLEMENTATION                                           0.0094935
0007 1A01F2304433A1          PLANNING                                                 0.0094465
0008 1A01F2304408B1          IMPLEMENTATION                                           0.0093030
0009 1A01F2306328A1          PLANNING                                                 0.0092480
0010 1A01F2305401B1          IMPLEMENTATION                                           0.0091569
0011 1A01F2301412A1          PLANNING                                                 0.0091053
0012 1A01F2304408C1          ANALYSIS                                                 0.0091051
0013 1A01F2302417A1          PLANNING                                                 0.0089494
0014 1A01F2305415A1          PLANNING                                                 0.0087912
0015 1A01F2305415B1          IMPLEMENTATION                                           0.0087012
0016 1A01F2302417B1          IMPLEMENTATION                                           0.0086591
0017 1A01F2305327B1          IMPLEMENTATION                                           0.0084839
0018 1A01F2302417C1          ANALYSIS                                                 0.0081915
0019 1A01F2305231A1          PLANNING                                                 0.0081843
0020 1A01F2305419B1          IMPLEMENTATION                                           0.0080693
0021 1A01F2304433C1          ANALYSIS                                                 0.0077406
0022 1A01F2306232A1          PLANNING                                                 0.0076132
0023 1A01F2301414A1          PLANNING                                                 0.0073721
0024 1A01F2304427B1          MPLEMENTATION                                            0.0073138
0025 1A01F2305415C1          ANALYSIS                                                 0.0073099
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Figure VII - 6 Student Branch Relevance Listing of the PIA Level (1 of 2)

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              TOTAL DIRECT RELEVANCE OF THE PLAN-IMPL-ANAL
  RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK      ID                          TITLE                                    RELEVANCE

0270 1A01F2304309C1          ANALYSIS                                          0.0005926
0271 1A01F2111126A1          PLANNING                                          0.0005723
0272 1A01F2111105B1          IMPLEMENTATION                                    0.0005652
0273 1A01F2209107C1          ANALYSIS                                          0.0005244
0274 1A01F2111126C1          ANALYSIS                                          0.0005002
0275 1A01F2111104A1          PLANNING                                          0.0004982
0276 1A01F2111102C1          ANALYSIS                                          0.0004864
0277 1A01F2112122B1          IMPLEMENTATION                                    0.0004718
0278 1A01F2111102B1          IMPLEMENTATION                                    0.0004513
0279 1A01F2209107B1          IMPLEMENTATION                                    0.0004501
0280 1A01F2111126B1          IMPLEMENTATION                                    0.0004136
0281 1A01F2111104C1          ANALYSIS                                          0.0004130
0282 1A01F2108331C1          ANALYSIS                                          0.0003891
0283 1A01F2111104B1          IMPLEMENTATION                                    0.0003517
0284 1A01F2108331B1          IMPLEMENTATION                                    0.0003491
0285 1A01F2305241B1          IMPLEMENTATION                                    0.0003465
0286 1A01F2108325C1          ANALYSIS                                          0.0003411
0287 1A01F2111117A1          PLANNING                                          0.0002618
0288 1A01F2111117C1          ANALYSIS                                          0.0002340
0289 1A01F2112111B1          IMPLEMENTATION                                    0.0002201
0290 1A01F2111117B1          IMPLEMENTATION                                    0.0001871
0291 1A01F2302322C1          ANALYSIS                                          0.0001177
0292 1A01F2305241C1          ANALYSIS                                          0.0001108
0293 1A01F2108337C1          ANALYSIS                                          0.0000779
0294 1A01F2302333C1          ANALYSIS                                          0.0000000
0295 1A01F2305231C1          ANALYSIS                                          0.0000000
0296 1A01F2305327C1          ANALYSIS                                          0.0000000
0297 1A01F2305418C1          ANALYSIS                                          0.0000000
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Figure VII - 6   Student Branch Relevance Listing of the PIA Level   (2 of 2)

VIII. APPENDICES

A. Study Personnel and Their Comments

1. Introduction

The evaluation team consisted of a balanced interdisciplinary group of students, educators, administrators and management personnel. This section includes the resumes of all adult participants and a listing of students by name, grade and school. The educators and students were asked to submit their comments and criticism on any facet of the Mobile Science Lab program and the Evaluation Phase. All responses are included verbatum (with only spelling errors corrected.)

All educator participants in the balloting sessions were an integral part of the entire evaluation from inception to completion. The student comments are, of course, from a wide cross-section of program participation in terms of years in the program and group level of experience.

The evaluation contained a high degree of emphasis on measuring the scientific value of the Mobile Science Laboratory program, but it was well recognized that there are many other facets that reflect on the efficacy of an objective analysis. Examination of the array of talent represented by the evaluation team will illustrate that it was well rounded and qualified to make assessments in all phases of the evaluation. Their interest and dedication to this excellent program is clearly evident in the sincere comments of both educators and students.

2. ALJ Associates, Inc. Resumes

Mr. A. L. Jestice

Mr. Jestice studied at Denver University, University of Minnesota, and received his degree in engineering/operations research from George Washington University. He has studied extensively in the fields of decision theory, economics, psychology, and international affairs. He has been deeply involved in education needs while serving in various roles in the PTA and in teaching. He has been called on as an operations research specialist to give courses, guest lectures, etc. for the University of Minnesota, UCLA, Federal Management Conference, Washington Operations Research Council, George Washington University, Brookings Institute, DDR&E, the Institute of Management Sciences, Operations Research Society of America, Army Advanced Management Training Schools et al. Mr. Jestice is founder and President of ALJ Associates, Inc.

Mr. J. L. Kirk

Mr. Kirk received his B.S. in politics, economics, and engineering from the Massachusetts Institute of Technology in 1964. He is in the process of writing a thesis to complete the requirement for M.S. in operations research at George Washington University. Mr. Kirk has worked in systems analysis for five years with Honeywell, Inc., the U.S. Government and ALJ Associates, Inc. He is presently an Associate with ALJ Associates, Inc.

Mr. C. A. Taylor

Mr. Taylor received his B.A. in 1945 and M.A. in 1955, both in sociology and statistics from the University of Florida. He is studying for his Ph.D. in operations research at American University. Mr. Taylor has 25 years experience in systems analysis covering a broad spectrum of education activities including teaching at the high school and college level. He has done development work in mathematical modeling and simulation for Naval Aviator Training, Bio-Medical Statistical applications and in criminology studies. He is presently an Associate with ALJ Associates, Inc.

Mr. R. Ostrich

Mr. Ostrich received his B.A. in 1950 and M.A. in 1953 both in psychology from George Washington University. He is now completing his doctoral dissertation. He has received his certificate of doctoral candidacy for his Ph.D. in history from the University of Pittsburgh. During his 20 years of research activities in education and medical arenas Mr. Ostrich has performed extensive studies in improvement of perception capabilities, common skills and knowledge of individuals. He is presently an Associate with ALJ Associates, Inc.

Mr. A. A. Hunt

Mr. Hunt attended Trenton State College, Northern Virginia University and Electronic Computer Programming Institute of Virginia where he graduated summa cum laude as a programmer, and is now enrolled in George Washington University. Mr. Hunt has considerable experience with the application of the PATTERN methodology on various computers. He is presently an Associate with ALJ Associates, Inc.

Mrs. E. W. Kirk

Mrs. Kirk received her B.S. in French from the University of Georgia in 1965. She has also pursued course work towards an M.A. in education at the University of Maryland. Mrs. Kirk has taught secondary school for four years, presently French at Randolph Junior High School in Rockville, Maryland.

3. Educators

a. Resumes

Mr. S. R. Breckner

Mr. Breckner recieved his B.S. in education from Winona State College in 1946. He has studied further at the graduate level in mathematics and science, his most recent experience being at the Introductory Physical Science Institute, Nebraska Wesleyan University. He has taught in secondary schools for 27 years, presently teaching introductory physical science at the eighth grade level in Southwest Junior High School in Albert Lea.

Mr. R. C. Clark

Mr. Clark has done considerable work toward a doctorate degree with credits from Stanford, University at Redlands, and San Francisco State college. He is the new State Science Consultant for Minnesota. Mr. Clark came to Minnesota from Lompac, California where he was science supervisor for the elementary schools. He has taught biology in high school during which time he developed and taught a course in marine biology.

Mr. George Denzene

Mr. Denzene recieved his B.S. in Social Studies from University of Minnesota in 1942. He recieved his M.A. in history from University of Minnesota in 1947. Mr Denzene has also done other graduate level study including summer sessions at Northwestern University and Ohio State University. He has taught in secondary schools for 20 years and is now teaching U.S. and world history at the tenth and eleventh grade level in Albert Lea.

Mr. V. L. Doss

Mr. Doss recieved his B.S. in Social Studies from Mankato State College in 1953. He recieved his M. Ed. in English from Mankato State College in 1961. Mr Doss has taught secondary school for 13 years, his present assignment being English and social studies at the seventh grade level at Southwest Junior High School in Albert Lea.

Mrs. Robert Entorf

Mrs. Entorf received her B.S. in Education from Iowa State University in 1946. She has also pursued various graduate level studies, her most recent experience being elementary science methods at Mankato State University. Mrs. Entorf has taught secondary school for 6 years and is presently one of two Elementary Science Resource Teachers assigned to the Mobile Science Laboratory.

Mr. E. Erickson

Mr. Erickson recieved his B.S. in Business Education from Mankato State College in 1951. He recieved his M.S. in Business education in 1960 from Mankato State College. Mr. Erickson has also pursued various graduate level studies. He has taught secondary school for 18 years, his present assignment being business education department chariman at senior high school in Albert Lea.

Mr. R. Harding

Mr. Harding recieved his B.E. in education from Bemidji State College in 1939. He recieved his M.A. from the University of Minnesota in 1956. He has also pursued various graduate studies. Mr. Harding has 28 years experience teaching at the elementary and secondary level. He is presently teaching earth science at the ninth grade level in Albert Lea.

Mr. M. Kyllo

Mr. Kyllo received his B.S. in Agriculture from University of Minnesota in 1951. He has also pursued graduate studies in conservation and biology. He has taught 17 years in adult and secondary education. Mr. Kyllo is presently teaching biology at the seventh grade level in Albert Lea.

Mr. M. Lawrence

Mr. Lawrence received his B.S. in education from Mankato State College in 1961. He received his M.A. in elementary administration from Mankato State College in 1964. Mr. Lawrence has taught 8 years at elementary level. He is presently the principal at Lakeview Elementary School.

Sister Monique

Sister Monique recieved her B.S. in education from College of St. Teresa in 1960. She has also pursued graduate studies most recently at Bradley University in science. Sister Monique has taught 7 years at the elementary and secondary level and is presently principal at St. Theodore Grade School in Albert Lea.

Mr. K. D. Pederson

Mr. Pederson recieved his B.S. in social studies from Winona State College in 1957. He received his M.A. in education administration from the University of Minnesota in 1961. Mr. Pederson has taught secondary school for 5 years and has been an administrator at secondary level for 6 years. He is presently senior high school principal in Albert Lea.

Mr. R. Schmidt

Mr. Schmidt received his B.A. in science from Augustana College in 1949. He has also pursued graduate studies, most recently mathematics at Kansas State University. Mr. Schmidt has taught 16 years at the secondary level and is presently teaching mathematics in Albert Lea.

b. Educator Evaluation Comments

Teacher No. 1

"1. Criticism--Pressure of time (more time needed and drawn out).

2. Attitude--The best experience I have had in a good long time. We tend to get biased in our judgment of other areas of learning and the efforts of others to bring about educational change and experi-mentation in education. I thought I changed my thinking as a teacher for the better. I became more rational.

I learned new ways of approaching problems. This is one of the few really worthwhile experiences that I have encountered in the field of education. I think the plan should be applied to all the subject matter we now teach. What to teach, How to teach it, When to teach it and Where to teach it. I am certain that inroads of this method into education could and would improve the vast sum we now spend for education that are wasted because we have employed the wrong approach (Aristoblean vs. Scientific Method) at the wrong time and in the wrong place.

I worked a total of 50 hours--other than eating meals over a four day period, and I enjoy what I did so much that it carried over in discussion at mealtime. This is a rarity on any project.

I was so greatly impressed with the caliber of leaderships, especially Joe Kirk, one of the most impressive, brilliant, driving, dilligent and considerate leaders one could ask for and work with.

It was a highlight, a rewarding experience one experience not only useful to me, but useful to society in understanding, and advancement in scientific thought processes and development.

My thanks should really be expressed to all those who tolerated my opinion who conceded to my vigorous stands and we enjoyed intellectual fellowships. My thanks are to be expressed to those who asked me to participate. I was rewarded far greater than the monetary considerations involved!

1. The different personalities and different educational and experience background of our leaders were very desirable.
    a. They (leaders) could have been rotated after completion of each book. (More standardization)

2. It took Aaron Jestice longer to get to the point of a topic than Joe Kirk. The give and take of these leaders was desirable and for the most part beneficial.

3. Almost imperative was more time to read the material--some of the work could have been done on PACE by teachers, and lay people after they had several days of experience from the leaders of PATTERN Experience is the most important factor in making critical evaluations.

4. Please--I would appreciate a resume of this information--but I would like more information on the P.I.A. outline form. An excellent problem solving approach. Most desirable and useful for the solution of subjective problems in the critical evaluation scheme.

The PACE project could have been done very exactingly had one read one book, and then spent shorter periods of time--2-4 hours just discussing 2 to 5 projects involved. To do real justice to the evaluation, time, is the critical point, how much available, and how effectively used. "

Teacher No. 2

"I have never really participated in an educational experience that generated as much effort in the field of original thinking as this experience did. I think that the evaluation efforts did arrive at balloting criteria that have validity as applied to the over all evaluation.

I think that the pressure of time was an adverse factor that worked against a thorough analysis. There were many collateral benefits such as new bridges of communications within District 241. An area of cooperation between District 241 and the State Dept. of Education, and a reinforcement of the cooperation between District 241 and our local parochial school system.

I benefited greatly by working with the acknowledged experts in the field. I think I have gained valuable insights into the logic of decision making. I also think that this machinery can be successfully adapted to classroom instruction in logical thinking by the device of simulation games. I will be very interested in any advancements along this particular line of endeavor.

In short, it was a very satisfying educational experience and I thank you for the opportunity to participate."

Teacher No. 3

"Very enlightening in regard to analysis of the Mobile Science Laboratory program. Many intangible facets brought into discussion for dissecting the operation, staffing, location, funding, research projects and significance of the total program impact upon the whole community.

The very frank and open dissertations were a great aid in evaluating the past performance, assimilating the present and predicting the future use of the Mobile Science Laboratory program.

The extremely concentrated and lengthy sessions were a bit tiring. I am still digesting the knowledge acquired.

Very good sessions, good for me, good for futher expansion of the program.

All participants of high caliber and qualifications!!!"

Teacher No. 4

"In all the sessions were stimulating. They taught me a bit more concerning other peoples' points of view. I now have a more tolerant attitude concerning science. The interaction of faculty members was particularly worthwhile.

I felt at times that too much stress was placed on resolving certain differences which had little to do with interpretation of criteria--perhaps the numbers could have stood as orginially entered. After a while it should have been possible for the group to have arrived at some agreements without direct leadership--this would have saved much time. The sense of humor of "our leader" was particularly helpful in keeping a certain "lightness" in the group sessions--much more serious drive would have hindered progress actually.

I, myself, would have liked a bit more conciseness as to meals, arrangements ahead of time. It was very hard to plan too far ahead as a result."

Teacher No. 5

"I have worked on all levels:I felt that the entire process was very informative and interesting.

The spirit was contagious at all levels. The students responded enthusuastically and performed at a high productive level. They demonstrated a high level of understanding and dedication. People who had little or no knowledge of the Mobile Science Laboratory was able to see how it worked and were enthusiastic and worked extremely well as a team.

I got a lot of insights in the study of the project reports. It brought understanding to strong and weakness that will help in doing next years program. Also where to aid the student to bridge gap between writing up results and field work.

I felt that we were crowded for time and toward the end on very important work was necessarily not as well thought out and done too superficial."

Teacher No. 6

"At the outset let me say that the setting at the INN TOWNE was very pleasant and conducive to the task of evaluating the Mobile Science Laboratory. It seemed to me the working relationship of the Evaluation Committee and the ALJ staff was excellent. I was indeed pleased to be of service to the Mobile Science Lab.

The following comments cover the entire series of meetings but are more specific to the final four days, January 16-19.

The schedule was altogether too tight in that the hours were too long and too much to cover. Perhaps there would have more time for reflective decisions, although I'm not certain there would be much change in the decisions.

I would have appreciated having the projects in numerical order and the pages numbered for more ease in reference."

Teacher No. 7

"I felt the experience with the evaluation committee was quite unique. I believe the site (INN TOWNE MOTEL) added much to the inducement of good rational thinking.

The lack of distractions and interruptions added much to the effort of concentration. The atmosphere of debate and discussion for balloting was unique for arriving at decisions.

I feel that the awareness of this type of evaluation alone is quite stimulating. I did feel however, that we were trying to do too much in too short of a time, although I realize why this was necessary."

Teacher No. 8

"I felt the process to have value and possibilities in many areas of education evaluation.

Time is a consideration both lack of and the degree to which we had to push. There is a degree of sensitivity training and taking a hard look at rather subjective material which I find desirable.

In talking with others involved, I would think the small group makeup and the different leadership might have an effect upon thinking, output, and organization. Both positive and negative.

Again, I found the experience to be personally rewarding and I believe it was for most concerned. I will be interested in the type of results we receive from this type of input as I would like to be able to use the application in a variety of areas.

I felt many times that the knowledge of the ALJ monitor could have had an influence on the group decision. (Especially project level and up). Time did not permit settlement of this item."

Teacher No. 9

"The evaluation program was a most interesting and unusual experience. I'm certain that it broadened our ideas about evaluation and should stimulate improvement in our own evaluation opportunities.

Perhaps the number of summer science projects to be evaluated could have been reduced, or else one more committee to study them could have been used (increased in cost?)."

Teacher No. 10

"I found the interaction within the evaluating sessions very stimulating and most rewarding experiences of the weekend to me as an educator. I feel, however, that less should have been demanded of the group in the way of amount of material to be evaluated. I felt less time should have been spent on evaluation of student projects and more on the evaluation of the Mobile Science Laboratory itself."

Teacher No. 11

"My role with the evaluation committee was quite limited.

I took part only due to the illness of another member. I hope that my small contribution was in some way meaningful and conveyed to others the effectiveness of the Mobile Laboratories in the elementary science program.

I was impressed with the dedication and energy displayed by all members who worked the four days of January 16-19. It was their objective to arrive at a constructive and accurate evaluation."

4. Students Participating on Balloting Sessions

a. Name, Grade, School List

Name	Grade	School
Anderson, Janet	8	Brookside
Anfinson, Julie	8	Southwest
Ash, Charles	9	Southwest
Botton, Susan	9	Brookside
Boyum, Nancy	8	Brookside
Bruce, Jean	9	Brookside
Colby, Raymond	9	Southwest
Colby, Leigh	10	Sr. High
Dahl, Marcia	9	Brookside
Denton, Douglas	9	Southwest
Dreisbach, Nancy	8	Southwest
Durgin, Mike	9	Southwest
Erickson, Mark	11	Sr. High
Erickson, Mike	8	Southwest
Gendler, Stacey	9	Brookside
Gregarson, Jonathon	10	Sr. High
Gurwell, Joan	9	Brookside
Halverson, Dan	9	Southwest
Halverson, Paul	8	Brookside
Hanson, Kurt	9	Southwest
Harrison, Sue	8	Brookside
Hrinek, Andy	9	Brookside
Hromadko, Gail	8	Southwest
Hromadko, Gary	11	Sr. High
Jensen, Alan	11	Sr. High
Jensen, Annette	11	Emmons, Minnesota High School
Jensen, David	9	Brookside

Johnsrud, Lorraine	11	Sr. High
Johnsrud, Marlene	12	Sr. High
Lair, Patrick	8	Brookside
Langerud, Cindy	9	Brookside
Lubitz, Marvel	9	Brookside
Marsinski, Bruce	10	Sr. High
Matthies, Emily	9	Brookside
Moe, Bradley	9	Brookside
Modderman, Jane	8	Southwest
Parrish, Sharon	10	Sr. High
Phillips, Ann	8	Brookside
Phillips, William	10	Sr. High
Quackenbush, Jana	8	Southwest
Roberts, Mary Jane	11	Sr. High
Roberts, Warren	sophomore	Macalaster College
Saunders, Mary	9	Brookside
Schoeppach, Jean	8	Southwest
VanRiper, Denise	10	Sr. High
Vandergrift, Judy	10	Sr. High
Vaughn, Charles	11	Sr. High
Vaughn, Robert	10	Sr. High
Wahlstrom, Darrel	10	Sr. High
Wedge, Vicki	10	Sr. High
Williams, Debra	8	Brookside
Ziegler, Mary	8	Brookside
Zgoda, Terri	8	Brookside

b. Student Evaluation Comments

Student No. 1

I think the Planning should be done before going out on the project. This would leave more time available in the field. The PIA method is good and quite helpful, but I think it gets too involved.

The definitions may and are needed at times, but defining things such as loud, lake, and such is useless to me. The data format and planning of it is very helpful in sticking on what you goal is. The implementation should consist of, in my opinion, data, schedule kept and other things you have done. By writing it down you will keep in mind your objectives for the project. The plans for evaluation should have been explained in part so that these cards would have contained all the information obtained plus the conclusions and future plans. It is not the system itself, but the extensive detail that bothers me. I think the final results and "collection and development of sufficient data" should be stressed more than the planning after you've started.

The evaluation is terrific! It was very helpful. I think everyone should get to see just a little bit how it works. One big problem in my mind is the fact that the information found was not necessarily included. Perhaps the information was listed with the specimens, but we were not told what the correction sheets we got were for, so this could be corrected. Another problem was the fact that several people evaluated their own projects. It was hard enough knowing that this person did more but it doesn't show it, much less trying to forget what you yourself did or, for that matter, didn't do. Even still, the comments made about your project were very helpful.

It was hard to decide but being in groups and discussing it made it easier. The way it was done seemed wrong and hard to understand at first, but putting them together, I could see how it makes a complete picture. Something that was hard to compare was such different projects, yet if they were very similar, it would be hard also. This technique is fascinating and I am looking forward to seeing what is gotten out of it.

Student No. 2

The unilateral use of standardized cards, though beneficial as it may be to the analysis of various learning methods, is, in itself, a deterrent to the intent of the Mobile Science Lab project-this intent being the self instruction of students in scientific method with assistance by competent instructors. Formulation of one's own procedure, schedule, data format, etc., is essential to the success of one's project; however, time spent in repetitious recording of various phases of one's project limits the actual time available for execution of the phases and impairs the quality of the investigation. Instruction in writing papers and planning the essence of a project before the field trip would be more worthwhile and more time saving than directions for filling out cards can possibly be. Admittedly this would result in a less uniform project procedure when applied to a number of students, but the question arises--who is supposed to benefit from the experience of the field and classroom learning situations. Obviously the student. For this reason an effort should be made to eliminate any inconvience in project procedure for which the program is responsible.

Enough can't be said for the Mobile Lab porgram. An objective look would reveal one of the best possible ways to have students learn about the many natural principles involved in their particular fields of study. There can be no doubt that direct

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observation and analysis is of far greater benefit than this same observation and analysis related in a textbook.

If it is so necessary to have a method to analyze the learning processes of students, I see no reason why the principles employed in the cards couldn't be applied to a regular research write-up, thereby removing the redundancy now inherent in the cards, and providing for much more efficient science projects.

Student No. 3

I found it difficult to evaluate a couple of projects because they were lacking in certain areas in their information. But it was easy with projects which had the information.

I thought it was interesting to evaluate these projects.

I thought it was well organized plan to evaluate these projects.

The cards seemed like just extra work but they were really helpful once you got them.

I hope we are able to continue with our program. It was an interesting and educational summer.

Student No. 4

How I would improve rating system? I'd have all the students exchange papers and then evaluate only one. Not very good. I didn't think it would be so hard.

How would I change write-up of report? I wouldn't change the cards because that is a good way to put them in order if you mix them up.

I think this is a good system to work with because it is kind of an advanced way of helping a person understand his or her project better and also help a person reading this project to get more out of it.

Science Program:I don't think we should have to work on our cards as much because we spend over half our time working on them and usually the rest of the time we were always being taken some place. But still I like the cards since they help plan the project real well you ought to give us the cards at least a month ahead so we have time to plan and then that would give us more time to work on our project.

I would like to see you have a science program last for about six weeks that way you could see more things. You could divide the six weeks into three equal parts, the first 2 weeks work on the cards the second two weeks work on just the project and the last two weeks then take us around to see the things like sights, people (speakers), mines, etc.

You should also have the Mobile Science lab start a science club that will be like have the meetings after school, take trips, camp out on holidays, etc.

Student No. 5

The PIA level evaluation was good in setup, even though you couldn't tell if the project was good or bad, since they do this on project level, it's okay. Some of the criteria were hard to answer, like whether it was flexible because sometimes you didn't know if they changed their project or not. Also the question on resources since sometimes they might have used them and not written down the names of them.

On the level of the whole project, I feel that the cards or whatever used should be started and nearly completed before starting anywhere, since they are time consuming. Also, I feel that a smaller number of phases be made because I think the teahcers need more rest than was given and also an opportunity to get away from the kids and each other.

I feel that cards of the like are a good idea because you have to plan in detail before you start and you should know and understand what you're doing.

Evaluation by the students from the project is good because they know what the conditions were for the projects and have probably experienced them also sometimes too, its a good idea to put the students into groups with projects unlike their own so they can see if it is really organized and understandable because they can't read anything into them because he doens't know as much about the subject.

I think that the people evaluating should be informed on what is happening in the evaluation because confusion of what to do in those handling or leading the evaluation of the group doesn't help the ones doing the evaluation.

Make sure a definite understanding is reached in the meanings of the criteria.

Student No. 6

1. More teachers to specialize in each area. So that almost every group of students has a teacher which knows about their area of study.

2. Also more help on using these cards because they're very hard to understand.

3. I think evaluation should consist of talking about the S.S.S. program. So if it is continued (hopefully) it is for those who learn and enjoy it.

A. Use of cards:I feel that the cards serve mixed purposes. While on one hand they give a semblence of order, they also are extremely time consuming. I think that use of the cards should be a matter of personal preference.

B. Length of program:The program should be lengthened to encompass a fourth phase, (excluding basic). If this were done, the mobile unit could give programs to all students from grade seven to graduation. I think that upon completing all four phases, students should be entitled to high school extra credits in science.

The amount of students assigned to each phase should be limited to no more than twenty five.

C. Criteria (PIA):I think the use of planning, implementation, and analysis should become a matter of the students own needs. If the project by its nature, is not of the type that required careful analysis, for example, then that phase of the project should be omitted.

D. A few suggestions as to the summer science program:(1) hire a full time director, (2) expand the program, (3) more classroom work, (4) more time to work on projects, (5) more detailed equipment (6) three teachers to a phase, (7) participation in other districts, and (8) besides biology, geology, and conservation, more subjects.

Student No. 7

The cards system worked good this last summer. It helped the people to plan out their projects and to summarize it. I think we should continue with the courses and to spread to other cities.

The summer program was interesting and fun. I hope there is a phase 4 or 5 the next year. I like the cards since it helped me to a better and well done project. It makes you feel rewarded when you take up a course like this and also shows you have accomplished something. I think you should give out rewards for joining it. If you could I think you should have it for longer than 4 weeks.

I don't have anything to critize about it.

Student No. 8

"Information" might be substituted for "data". "Guidelines" could be used for "criteria". "Carrying out" could be used for "implementation".

Improvements:(1) Standardize methods for filling out cards, (2) Larger--more space on cards, (3.) A definite place to enter data from the field, and (4.) Simplified numbering system on cards.

Student No. 9

I feel this way is almost nearly perfect, except for one thing which is number "educational value for future endeavors". You should have stated more clearly what you wanted. Like how much they did learn and how important it is or how important will it be in the future for the occupation you choose.

The cards were a little difficult.

Student No. 10

What difficuluties were found in the evaluation processes? Judging each project separately was hard and difficult.

Was it interesting or of value to you? Very much, it helps your future.

Suggestions for changes in cards:More like scientific studies like term papers.

General Comments:(1) Better food diet, (2) More leisure time, (3) Better recreation facilities, (4) Hot water, and (5) Better camping areas.

Student No. 11

1. I found it hard to do when people left out information, or when there was too much, and things that did not matter.

2. I liked it, I got to see other peoples' projects, and what they did, and how they did it.

3. Have it so that there is one for each box instead of all of them add up to one.

4. Instead of cards, I think a sheet of paper, and up on the top have plan and so on.

5. You could feed us better.

Student No. 12

The card idea wasn't too bad. The only reason most of the kids hated it so was because with them they would have to do a little work. I did think, however, that the cards could have been better explained so we would know how to use them.

I was disappointed in the field trips themselves. The time we could have used for going to fossil areas was all taken up by specially planned lectures and tours which hardly had anything to do with many of the projects, were boring, and were re-runs from the Basic program. As a result my project was a complete flop. I collected no fossils.

Student No. 13

How would I improve the rating system?:I would have the rating equal out to a bigger number but I thought that it wasn't so hard after you got use to how it worked out.

How would I change the write-up of project?:I would have the cards in an order in which they would follow in the project you are working.

Student No. 14

1. I would leave it the same, as this is the best method to evaluate a program of this size. I like it personally, and I enjoyed it if it wasn't so long.

I would leave it also, but I wouldn't put as great an emphasis on the cards used to write it up.

Student No. 15

I think you should have more time to collect and organize your specimens for your project. The cards take up all the time so you don't have time to get the specimens and materials you need for the project.

I was on Phase I this year with the cards and on Basic last year without them, then I got a lot more done on basic and got a good fossil collection, but this year I didn't get anything the reason is because I spent so much time on the cards.

Student No. 16

1. That they should have more teachers to teach summer science and so that when students need help the teachers could help.

2. Have more help on cards or not as many cards.

Student No. 17

1. The cards were very difficult because I don't think we really got a complete explanation of the cards.

2. This group is a perfect size. This job was interesting.

Student No. 18

I think they could be arranged a little bit better, but I think they helped a lot.

Student No. 19

I think that the cards are the things that brought down the enjoyment of the program.

Student No. 20

If we ever evaluate again, I think they should have numbers on the pages of the group book so we could find things quicker. But, personally, I don't think we should use this type of cards again, because I don't believe that they are that understandable, especially for kids in the 7th grade, and I don't think they are necessary. I think it would be just as easy to write a paper on your project instead of doing cards. I think they take too much time and if we did do it again they should make the cards more understandable and easier.

Student No. 21

For ease of evaluation the project numbers should be presented in ascending order in the booklet and the pages should be numbered. In addition the listing of projects on the evaluation sheet should be in the same order as appears in the booklet.

The terms in the criteria section were not chosen with clarity in mind and words such as expedient should not be used.

If at all possible a project whose end product is a map or chart (e.g. surveying) should have this chart included.

Student No. 22

It works quite well, though I would appreciate more time for the evaluation--(spread out more).

I would have more written about the data gathered and more on what they used and how they did it.

Student No. 23

You should put the reports in the book in order. I think it would save a lot of time instead of trying to find the correct report. I think you should use the terms so you can understand it better. I think the evaluation was good and you could understand it.

Student No. 24

To put it in a different way so it would be easier to fill out the cards.

Student No. 25

1. I found it difficult in some cases to evaluate these projects.

2. Yes, I thought it was interesting to work on the projects.

3. No.

4. I think we should either keep them the way they are or ban them.

5. None.

Student No. 26

1. (a) It helped my note taking, and I have a good basic understanding of the evaluation.

(b) At first I didn't understand it, but who did?

2. I judged the projects a little on my level, but with the PIA I did it strictly between the PIA itself.

Student No. 27

I understood the evaluation. I didn't like the cards at all. They were hard to do, and didn't make much sense.

To change this course, I would leave out the cards, I don't know what I would put it its place.

I feel this is a fair evaluation, but I don't think a person should evaluate his own project.

Student No. 28

1. Yes, I understand this form of evaluation. I didn't really like it very much because it got boring at times.

2. I think they should leave the cards and the form the way it is now because you can get more out of it this way.

3. I was judging on a same level as my own work.

4. I do feel that this is a fair evaluation of projects.

Student No. 29

1. Yes, I understood this form of evaluation. I really didn't like all the work involved.

2. If I could change it I would make the cards shorter.

3. Yes, I mostly judged them on the level I was in.

4. Yes, I think this is a fair evaluation. Yes, I will accept the judgment of the group on my project.

B. Relevance Guide Book

1. Introduction

It has been indicated that no analysis can be better than the expertise of the evaluators and the information available to them. As much effort as practical was devoted to this task. This section discusses the questionnaires and an analysis of the data that was provided to the educators, includes a representative program description that was one of ten prepared from a review of over 200 program proposals, and the data received from responses to individualized letters that were mailed to the included list of 134 PACE Program Directors.

In addition, ALJ Associates, Inc. collected a variety of source and background material to form the basis for the relevance network and relevance guide book. Our research was directed toward collection of relevant PACE educational data and was comprised of a series of visits, telephone calls, and letters to various educational authorities and directrates. Included among these contacts were the Office of Education, the National Education Association, the Library of Congress, the Educational Service Bureau and four of the Universities in the Washington, D. C. area.

A briefing to the Office of Education on the evaluation was conducted in December 1968 by the staff of ALJ Associates, Inc. Also, a series of meetings were conducted in Albert Lea informing the evaluation committee of progress in structuring the network and developing the criteria. The committee was composed of several teachers, principals, and the state science advisor. The first meeting was held in early November, followed by an early December meeting on questionnaires, a late December session for students to assign relevance, and a mid-January session for committee relevance assignment.

The final sessions were tape recorded to enable careful examination of the discussion periods. This allowed a detailed analysis of the issues enunciated during the meeting.

2. Questionnaires

a. Development

The questionnaires were developed specifically to form the basis for the Relevance Guide Book at the Function and Curriculum level. The need for information beyond that immediately available to the relevance assigners was evident. To inform questionnaire recipients about the Mobile Science Laboratory program a series of newsletters was published on its various facets. These were then distributed through the schools to parents.

One newsletter was specifically devoted to the elementary program, while the rest covered various parts of the secondary program. The newsletters were composed at Albert Lea and printed by ALJ Associates, Inc. (Samples of elementary and secondary newsletter are included.)

The questionnaires developed through a joint effort of the educator evaluation committee and ALJ Associates, Inc. Each group developed a set of questions, which was then merged by ALJ Associates, Inc. The merged set was reviewed by the evaluation committee, amended and printed by ALJ Associates, Inc. The questionnaires did not contain the normal set of survey yes/no questions. Instead most questions were directed at amplifying a facet of one of the criteria. Some reference questions were also included. A separate questionnaire was composed for each of the groups of interest:school administrators, counselors, educators, secondary students, and parents of secondary and elementary parents. The last two groups could not be polled by the same kind of questions as the first groups, but an effort was made in all the questionnaires to force a choice by eliminating middle-ground and "don't know" answers.

The questionnaires were sent to all school principals, counselors and teachers in the school district. All secondary students who had participated in the program also received questionnaires. Because of time constraints, a random sample of 300 elementary and 300 secondary parents were selected to receive questionnaires.

Problems with air freight and the weather delayed receipt of the questionnaires in Albert Lea and their return to Washington for processing. However, this problem was overcome and processing completed in time to publish the Relevance Guide Book.

Each question of each questionnaire was analyzed, summarizing key points. Then all questions which applied to a criterion were merged to produce the final text under the criterion. The following is an example:

Secondary Parents

Question 1

The parents of secondary students felt that the Mobile Science Laboratory affected their children in several significant ways.

83% of the responding parents felt that the Mobile Science Laboratory engendered increased respect for nature and natural science. This selection was by far the most often chosen to describe the impact on their child.

Next most popular response was that of increased self-improvement and social maturity. 65% of the parents felt that this was an important feature of the Mobile Science Laboratory experience.

58% of the parents felt that participation in the Mobile Science Laboratory influenced the grades of the children. 51% felt the program fulfilled recreational needs.

44% felt that hobbies and out-of-school activities were influenced by the Mobile Science Laboratory. 27% felt that selection of science courses at school had been effected while 19% felt future jobs or profession had been influenced.

13% of the parents added a variety of comments ranging from no influence to filled vacation time to stimulated curiosity about science.

The final text consisted of merging similar analyses from ten other questions.

The following table refers the questions to the criteria.

Network Level	Criteria	Questionnaire #
Function	26	Ad 1,2,5; Co 1; Ed 4,7; Sp 1,2; EP 1,2,3; SS 4
	27	Ad 3,4; Ed 2,3,4
	28	Ad 3,4; Ed 2,3
	29	Ed 5
Curriculum	30	Co 3; Ed 8; SP 1,3,4; EP 1,2
	31	Co 1,3; Ed 1,4; Sp 1,3,4; EP 1,2; SS 1
	32	Co 3; Ed 9; SP 1,3,4,; EP 1,2
	33	Co 3,4; Ed 6, 10; SP 1,3,4; EP 1,2

Ad=Aministrator
Co=Counselor
Ed=Educator
SP=Secondary Parent
EP=Elementary Parent
SS=Secondary Student

A copy of the questionnaires and of the Function and Curriculum Relevance Guide Book follow. This guide book is included as it provides a good insight of the reaction of the District 241 community to the MSL program.

b. Sample Questionnaires

MOBILE SCIENCE LABORATORY EVALUATION

Check one or more of the following indicating your association with the Mobile Science Laboratory program.

A. Participant in one or more of the courses offered.

B. A son or daughter has participated in the Mobile Science Laboratory program.

C. Have seen the Mobile Science Laboratory in operation on the elementary school level.

D. Viewed film on Mobile Science Laboratory.

E. Inspected Mobile Science Laboratory as part of open house or PTA meeting.

F. Read or heard of program in:

1. Newspaper
2. Brochures prepared through school
3. Other (Radio, TV, etc.)
4. As a conservation volunteer

G. Had personal contact with program or persons involved in planning the program.

H. Teachers

_____ Science
_____ Other
_____ Mobile Science Laboratory ____Yes _____No

TO ENSURE YOUR IDEAS ARE INCLUDED IN THE MOBILE SCIENCE LABORATORY EVALUATION, THE ATTACHED QUESTIONNAIRE MUST BE RETURNED BY MAIL BEFORE THURSDAY, DECEMBER 26.

ADMINISTRATION

1) What possibilities could you offer to motivate teachers to participate in an in-service Mobile Science Laboratory program?

2) In adapting the Mobile Science Laboratory program to Adult Education rank numerically the following potential benefits:

______ a) General science background
______ b) High School science credit
______ c) Avocation aspect
______ d) __________
______ e) __________

3) How can the usage of the Mobile Science Laboratory be changed to increase availability of space, materials and equipment, either where none existed or in improving present capability?

4) If the Mobile Science Laboratory program were expanded, what impact would this have on availability of space, materials and equipment?

5) How could the Mobile Science Laboratory be used to better serve as a public relations instrument for the school district?

COUNSELORS

1) How has the Mobile Science Laboratory program affected requests for new course electives by the students?

2) How does the Mobile Science Laboratory program fit into total academic course offering?

3) From your experience, what benefits do students gain through participation in the Mobile Science Laboratory program?

4) In considering the Mobile Science Laboratory program for student academic recognition, rank the following:

______ a) High school science credit
______ b) Achievement award, e.g. certificate, microscope
______ c) Augment science grade
______ d) __________
______ e) __________

5) What kind of Mobile Science Laboratory information is needed to advise the student?

EDUCATOR

1) Rank numerically the following educational student benefits derived from the Mobile Science Laboratory program:

______ a) Independent self-study
______ b) Extension of previous learning
______ c) Real-world applicability
______ d) Laboratory experience
______ e) Scientific awareness
______ f) ______________
______ g) ______________

2) How can the usage of the Mobile Science Laboratory be changed to increase availability of space, materials and equipment, either where none existed or in imporving present capability?

3) If the Mobile Science Laboratory program were expanded, what impact would this have on availability of space, materials and equipment?

4) What impact would discontinuance of the Mobile Science Laboratory have on the student's learning science?

5) To improve your science teaching, what additional training would you be interested in acquiring through the use of the Mobile Science Laboratory?

6) Rank numerically the following teacher benefits in considering field training in the Mobile Science Laboratory in the summer:

______ a) College credit
______ b) Financial compensation
______ c) Fulfillment of school contractual agreement on extended school year
______ d) Developing and extending science curriculum studies
______ e) ____________

7) If the Mobile Science Laboratory program were expanded, what impact would this have on augmenting student familiarity with science?

8) Rank numerically the following student physical benefits derived from the Mobile Science Laboratory program:

______ a) Exposure to natural environment, e.g. fresh air
______ b) Organized activity, e.g. sports
______ c) Individual activity, e.g. rock collecting
______ d) ____________

9) Rank numerically the following student social benefits derived from the Mobile Science Laboratory program:

______ a) Increased group relatedness
______ b) Contact with government and community resources
______ c) Camping experience
______ d) ____________

10) Rank numerically the following indices of student self-improvment derived from the Mobile Science Laboratory program:

______ a) Motivation
______ b) Leadership
______ c) Personality
______ d) Self-reliance
______ e) __________

TO THE PARENTS OF SECONDARY STUDENTS

1) In what manner has the Mobile Science Laboratory program affected your child? (Mark as many as applicable)

_____ a) Increased respect for nature or natural science
_____ b) Selection of science courses at school
_____ c) Success at school (grades, new friends, etc.)
_____ d) Hobbies, out-of-school activities, scouting, etc.
_____ e) Future job or profession in science area
_____ f) Self-improvement, social maturity
_____ g) Fulfilled recreational needs
_____ h) __________

2) What is your opinion of the scope of the secondary Mobile Science Laboratory program?

_____ a) Continue program at present level
_____ b) Expand the program
_____ c) Discontinue the program
_____ d) Not familiar with the program
_____ e) __________

Please explain your response:

3) What Mobile Science Laboratory science activities has your child conducted at home?

4) What Mobile Science Laboratory activities in particular has your child discussed iwth you?

5) Would you be willing to participate in local financing of the Mobile science summer science program to ensure its continuance?

_____ a) No
_____ b) Yes ____ As taxes, ____ As nominal individual partial payment

TO THE PARENTS OF ELEMENTARY PUPILS

1) What Mobile Science Laboratory activities in particular has your child discussed with you?

2) What Mobile Science Laboratory science activities has your child experimented with at home?

3) Do you want your child to take part in the junior high summer Mobile Science Laboratory program?

______ a) Yes
______ b) No

Please explain your response:

4) What is your opinion about the elementary Mobile Science Laboratory program?

______ a) Continue the program at present level
______ b) Expand the program
______ c) Discontinue the program
______ d) Not familiar with the program
______ e) __________

Please explain your response:

SECONDARY STUDENTS

1) How does the Mobile Science Laboratory program fit into your academic course plans?

2) In which of the following does the Mobile Science Laboratory program affect you?

   ______ a) Future plans: 1. High School

   2. College

   3. Occupation (including military)

   ______ b) Developing outside interests (Church activities, hobbies, 4-H, scouting, etc.)

   ______ c) Self (improvement, motivation, reliance, leadership, understanding others)

   ______ d) School achievement (awards, grades, etc.)

   ______ e) Other

   ______ f) No help

3) What offerings or improvements could be made to Mobile Science Laboratory program?

   ______ a) One week excursion

   ______ b) 6-week program

   ______ c) High school science credit

   ______ d) Achievement award, e.g. certificate, microscope

   ______ e) Augment science grade

   ______ f) Others ____________

4) What experience and knowledge have you gained through participation in the Mobile Science Laboratory program?

5) What was the main reason you participated in the Mobile Science Laboratory program?

______ a) Interest
______ b) Parents insisted
______ c) Seemed like nice vacation
______ d) Other

6) How many years have you been in the Mobile Science Laboratory program?

______ a) Number of years in program
______ b) Grade in school

C. Analysis of Questionnaires

a. Introduction

This analysis presents data gathered from questionnaires sent out to secondary students, parents of both secondary and elementary students, school counselors, educators, and school administrators.

The purpose of this Guide Book is to present some of the data necessary to assign authoritative relevance numbers using each of the criteria. The data here was collected through use of questions which were aimed at a particular criterion. The content and quality of the answers explain the variation in detail accorded to each criterion. Where possible the data was presented as it applied to each element at the level.

RELEVANCE GUIDE BOOK

FUNCTION AND CURRICULUM LEVELS

PREPARED FOR:

EVALUATION OF THE

MOBILE SCIENCE LABORATORY

26. PARTICIPANTS

To what degree does participation in the MSL program augment participant curiousity, knowledge and familiarity with science through elementary use, secondary use, teacher use, and community use?

This criterion assesses the impact of the MSL program on the participant, as the program is used by the element. The impact we are measuring involves the importance to the participant of the experience for educational benefit now and in the future.

Elementary Use

Elementary participation takes the form of scientific work, organized into units which are performed by each class in the MSL. The units are directed at a particular grade level and involve basic concepts in science such as magnetism, sound, light, rocks, etc. The classes are brought into the MSL (1/2 the class at a time for large classes) spending an amount of time which varies according to unit difficulty and grade level. This allows exposure to the child of a science program that his teacher might not be able to provide due to the lack of an adequate science background, as is often the case for the generalist that the elementary teacher must be. Expanded plans would include field trips of short duration during the school term or summer.

Teachers find the students more interested in science and better prepared to work in laboratory situations. Many teachers feel that the student, after participating in the MSL program, demonstrates a better understanding of science and that the opportunity to use the MSL provides an important motivative device for accomplishment in science learning. Some teachers find that there is a carry-over of this interest in learning to other subjects in the elementary class. Several teachers were unable to say what impact expansion of the MSL would have on augmenting elementary student familiarity with science, although most said that the MSL program as now constituted was an excellent program for their students.

Elementary parents noted that their children very frequently discussed experiments that they had observed or performed in the MSL. Pupils mentioned equipment that they were familiar with from use in the MSL program. This equipment included instruments such as machines, pulleys, magnets, compasses, helium balloons and bunson buners. The children expressed new interests promoted through the MSL program such as collecting insects and rocks. Parent-child discussions involved specific experiments, skills using scientific equipment and new interests stimulated by using the MSL.

Elementary parents stated that simple experiments were done at home as a result of the child's participation in the MSL. These experiments used some of the following equipment:wheels, pulleys, magnets, chemicals, and thermometers. Another activity fostered by the MSL was rock, fossil, insect and crayfish collection. Observation techniques were carried on in the home as well. These were applied to a thermometer experiment, butterfly hibernation, insect studies, along with observation of the effects of air pressure and gravity.

66% of the elementary parents stated that they want their children to participate in the junior high school MSL program. They justified this response with the following reasons:their children liked science, they enjoyed working in the MSL in the past, the MSL had provided good learning experience, the program offered the opportunity to travel, the MSL broadened the child's understanding of science and nature. Parents also thought that the MSL program provided a valuable learning experience, as well as broadening the child's knowledge of his environment. One parent found that the elementary MSL program was of the most value because "educators couldn't mess it up like they did everything else."

The 34% of the parents who did not want their children to participate in the MSL in junior high felt that:their child had no interest in the subject, the children were too young to decide, the MSL interfered with other summer activities, the program caused too great an inconvenience for parents in that they would have to provide transportation, that they would be out of the area in the summer, or that rural children had too much work to do at home.

Secondary Use

Junior and senior high school participation takes the form of summer field excursions for extended periods to places of scientific interest around the state. The students plan their own study project following an outline prepared by the project director. They are free to select any study topic they wish. Selections include collecting fossils, mapping lakes, and studying human sensitivity with respect to natural environment. The program has taken place during the summer months and could be expanded to include weekends, vacation periods during the school year, or after-school programs.

Counselors felt that participation in the MSL program had no apparent effect on student selection of electives. One noted that the junior high curriculum was prescribed and that little impact could therefore be noted.

Teachers felt that the impact of the MSL was evident in increased student interest and understanding in science. Several noted that increased field experience and increased ability to function in a laboratory environment were evident. Some few simply noted that "there is no end to the benefits." Other teachers saw an increased appreciation of the outdoors and of conservation, while some noted that there was more individual experimentation and that more self-discovery and self-directed activity was occurring.

The parents of secondary students felt that participation in the MSL affected their children in several significant ways. 83% of the responding parents beleived that the MSL engendered increased respect for nature and natural science. 65% of the parents felt that they saw increased self-improvement and social maturity in their child. 58% felt that participation in the MSL influenced the grades of their children. 51% felt that the problem fulfilled recreational needs, while 44% felt that hobbies and out-of-school activities were influenced. 27% felt that the selection of science courses at shcool had been affected, while 19% felt that future jobs or professions had been influenced. 13% of the parents made various comments such as "the MSL had no influence," "the MSL filled vacation time," "the MSL stimulated curiosity about science."

Many parents saw increased home scientific activity. Frequently mentioned were rock collecting and other collecting projects along with report writing or simply work on projects or experiments. Another frequent response, however, was that no activity from the MSL carried over to the home.

General discussions about the MSL program were carried on in the homes of the secondary students. The overwhelming response by parents was that the students discussed their projects and the field trips. Some mentioned that "day-to-day activities" or "all he participated in" were the principal topics.

Secondary students felt that the MSL provided immediate academic benefit in that it aided students in present science classes dealing with geology, biology, and paleontology, and that it promoted math appreciation. The MSL program also provided a background in the physical sciences, biology, and conservation in the opinion of the students. Use in the MSL of techniques of the scientific methodology broadened interest in science and served as a supplement to classroom learning. Students also felt that the MSL fit their academic science plans primarily in its application to future education plans. High school, college and future careers were about equally mentioned. While most reaction was that the MSL was academically valuable, 20% of the students were either undecided as to how it was valuable or were negative in their reaction. One child felt the MSL program interfered with band practice and on that basis was negative in his appraisal.

Students were asked to state what experience and knowledge they gained through participation in the MSL program. Generally most students listed specific skills and knowledge gained as pertained to their individual project. For example, the student whose project had to do with fossils learned most about how to identify and find fossils. Skills that were applicable beyond the MSL were also learned such as how to use reference materials, how to work in small and large groups for task accomplishment. Listening skills were also improved as reference people and experts contributed to the individual students learning experience. Observation skills were emphasized as scientists demonstrated experiments and techniques. Social interaction among the students, teachers and resource people allowed the students to learn to work with and get along with people. They learned to make new friends. Self-reliance and a sense of responsibility were mentioned by many students as a direct outgrowth of their work in the MSL program.

Recreational skills in camping out were mentioned by several students, while others felt the MSL offered the opportunity to visit new places. Still others enjoyed the exposure to the various types of jobs that had to do with science. One student learned to use a camera which excited a whole new curiosity for him. Broadened interests and expanded knowledge in various fields affected each of the children taking part in the MSL.

Teacher Use

In-service teacher use of the MSL would strengthen the science program substantially in the elementary area where generalists prevail. The MSL could be used as a research facility for junior and senior high science instructors who would have more specialized interests. It could be used as an adjunct laboratory especially for teachers, allowing some of the limitations now present on teacher research (such as space and availability) to be alleviated.

Community Use

Community participation in the MSL is also possible. Administrators felt that the emphasis of such a program would be most beneficial for general science background. High school credit for high school degree and the avocation improvement aspect were also mentioned as being relevant. The MSL could be moved around to the various shopping centers or other central locations for convenient access. Community participants would learn about scientific concepts that could be very useful to them in every day life. For example, fertilizer and nitrate experiments could be performed to help increase the understanding of their uses and impact on farming. Industrial chemical experiments might be possible. Also experiments and independent research would be possible for the adults who would desire it. The MSL would enable the community to keep abreast of the rapid scientific advances being made around the country today. It could demonstrate the impact of pollution through actual observation on extended field trips, as well as through laboratory experiment.

27. FACILITIES

To what degree does the use of the MSL by the function level element increase the space, materials and equipment available to instruct in laboratory science?

This criterion assesses the impact of the MSL program on the facilities which it makes available to the function element. It is simply the fact that more facilities are available, not that new facilities are offered where none previously existed.

In the elementary schools there is, of course, no scientific laboratory available; the MSL therefore represents a great increase over that condition. The MSL could serve as a resource center in science at any school. Equipment could be loaned from the MSL to the elementary classroom to promote follow-up activities. Use of the MSL also preserves classroom space. Many elementary teachers felt that this was one of the principal benefits of the MSL from the facilities standpoint. Laboratory experience will be available for the elementary student.

In the secondary use, the MSL provides additional laboratory space and provides the opportunity for field laboratory experience. The students have the opportunity to use scientific equipment and apply the equipment to a real situation. Field experiments are now a possibility for a number of secondary students. The MSL could also be used during the school year as a special experiment station for individual projects that might not be possible in the classroom. The MSL would also make available a number of laboratories to fill immediate needs of the secondary schools at a lower cost than the present classroom laboratories.

In-service facilities for instructing in science would be enhanced by the mobility of the MSL. It would provide a special location for in-service training in laboratory science. Also, it increases the materials available for this training. Teachers could have a laboratory to themselves is one possible use of the concept.

Community use of the MSL would familiarize parents with the laboratory in which their children participate. The MSL could be moved around the city to various central locations to permit easy public access. School open-house could be expanded to include sessions in the lab. The MSL would represent a large increase in facilities available for adult science education.

28. FULFILL DISTRICT 241 SCIENTIFIC EDUCATION REQUIREMENTS

To what degree does the MSL provide to the function level element ***new*** *opportunity to instruct in laboratory science by providing facilities where none previously existed? To what degree is the science education requirements of the element enhanced?*

The MSL provides new capability for the elementary program. There are presently no laboratory facilities at the elementary level in the district. The MSL allows students to move away from the textbook approach to science toward the operational approach which is more interesting and instructive. The laboratory makes available to the students the talents of various resource people from the community and selected agencies. The level of science education can be independent of the interest or the background of the elementary teacher. Elementary teachers feel that the amount and quality of science instruction is significantly increased by the MSL. An elementary summer program would also provide significant field experience in science to the mature elementary child. Elementary teachers believe that removal of this program would necessitate its replacement by an alternative means such as science resources at each school or expensive closed circuit TV.

The use of the MSL by the secondary students provides new opportunity for laboratory experience in the field. Students are now able to become familiar with the problems involved in planning and developing an experiment outside the classroom in more or less of a real-world situation. Week-end field trips and after school use of the MSL could expand the present capabilities of the program.

Since the MSL has become a part of the curriculum, in-service training in the laboratory is necessary for the elementary teacher.

29. PROVIDE INCREASED OPPORTUNITY FOR NEW TEACHING DEVICES

To what degree does use of the MSL by the function level element increase the opportunity to use new teaching devices such as discovery method, natural environment, and participant self-direction?

The students are removed from the familiar classroom surroundings to the MSL for the elementary use of the lab. The lab offers varied instruction which allows the child to experiment more freely than he could in the classroom. This is a new concept in the science education of the elementary child. Elementary teachers feel that this is an innovative tool and several would "hate to see it discontinued."

For secondary use of the lab, the student is taken out to a field location and there he is able to perform an experiment that he organized and planned. The student has complete responsibility for gathering data and directing his energies toward the completion of the project in the allotted time. He is very much self-directed and learns principally through the discovery method.

For in-service and teacher use of the lab, the MSL offers the opportunity to pursue individual projects in an experimental atmosphere free from limitations of space and availability of materials. Courses if field geology, field biology, or field botany could be offered. Conservation and general training in the use of equipment would be available.

For community use, the MSL offers numerous possibilities for adult education using the laboratory. Some of these, for example involve education in use of fertilizer and other farm-oriented applications using the newest scientific teaching techniques and the laboratory to emphasize these points.

The MSL has generated and also facilitated solving this in-service training requirement. The secondary school science teacher is generally a specialist in his field and has need for in-service training only in keeping abreast of new improvements in his field. The MSL could also satisfy this requirement.

The MSL provides new facilities and materials to the community. Presently little or no laboratory facilities are used in the adult education program. The MSL would provide these facilities and materials at convenient locations.

30. PHYSICAL BENEFITS

Assess the impact of the various curricula on the participant in the MSL in terms of physical benefits such as exposure to natural environment, participation in organized sports, and various forms of other physical activity.

Teachers felt that one benefit of the program was that of organized, physical activity. They considered individual activity and exposure to natural environment about equal in impact on the students and felt that both were substantially more important to the student than the organized activity aspect.

51% of the parents of secondary students felt that the recreational needs of their children were fulfilled through participation in the MSL. Also several parents reported that their child was more interested in the outdoors and in being outdoors. Many students continued their projects such as collecting and weather reporting after their experience in the MSL.

Students participated in organized games such as baseball and tag for recreational activities while at the camp site. Also individual activities such as exploring and walking were performed. The students for the most part lived in tents and were fed from the "chuck wagon" trailer accompanying the MSL.

31. COGNITIVE BENEFITS

Assess the impact of the various curricula on the participant in the MSL in terms of cognitive benefits such as independent self-directed study, extension of previous learning, real-world application, laboratory experience, individual attention.

Counselors felt that they had not seen distinct evidence of any cognitive benefits in so far as student selection of courses and electives was concerned. One counselor felt that the students were able to learn more science in the most natural way, through what they see around them rather than in the classroom situation.

Teachers felt that the important aspects of the criterion were laboratory experience, followed by scientific awareness, real-world applicability, extension of previous learning, and independent self-study, in that order. They felt that there was a substantial increase in the student's capability to use equipment applicable to an experiment and in experiment planning.

83% of the parents responding noted that the MSL engendered increased respect for science and nature. Increased knowledge about laboratories and equipment was also noted.

Students felt that the MSL was important in giving them field experience and in requiring self-direction planning of their activities. They saw immediate academic benefit in some of their classes and appreciated the broadened background in conservation and in the earth and life sciences.

32. SOCIAL BENEFITS

Assess the impact of the various curricula on the participant in the MSL in terms of social benefits such as group relatedness, contact with community officials, camping experience, leadership.

Counselors felt that the program increased the ability of the students to cooperate and to accept other students' ideas.

Teachers felt that the most important aspect was that of increased group relatedness. Contact with governmental and community resource personnel was judged second, followed by the benefits of camping together.

Parents felt that their children had made a number of new acquaintances and had come back from the experience more tolerant of group activities and group action.

33. AFFECTIVE BENEFITS

Assess the impact of the various curricula on the participant in the MSL in terms of affective benefits such as self-reliance, scientific awareness, motivation.

Counselors felt that some attitudes toward learning had changed under the impact of the MSL program.

Teachers felt that motivation was the principal benefit generated by the program. Self-reliance, leadership ability, and personality changes followed in that order.

65% of the parents felt that increased interest in self-improvement was evidenced after the program and the same percent saw more social maturity in their children.

The students felt overwhelmingly that their attitudes toward self-improvement, motivation, self-reliance, and understanding others changed after their MSL experience.

3. Sample Program Write-Up

a. Introduction

The following is an example of data prepared for the Relevance Guide Book program level from the proposals, and project directors responses.

b. FLOATING SCIENCE LABORATORY DESCRIPTION

Abstract

A floating marine science laboratory program will be offered to junior and senior high studnets from all public and nonpublic schools in the metropolitan county. The various disciplines of science--Biology, Physics, and Chemistry--will be integrated through the medium of oceanology to expand and enrich student understanding. Instructional materials will be developed for students of all ability levels. A 65-foot converted commercial sportfishing boat will serve as the laboratory. The boat will be equipped with equipment necessary to conduct scientific experiments. For example, students will set traps, collect and examine specimens through microscopes, and record data scientifically. In addition to learning about ocean plants and animals, the students will be instructed in navigation and in the physical properties of water, The students should gain an appreciation for the complexity of sea life and a realization that there are many vocational opportunities associated with marine science. Approximately 4,750 students will participate.

Emphasis on an exemplary program.

1. It is intended that the program of marine study shall be carried out as a floating laboratory boat. The design of the program and facilities are to be so structured as to fully meet the needs already described. The program shall utilize the techniques avaliable to commercial fishermen, scientists, and researchers to make soundings, collect specimens, and to accom-

plish many other related phases of marine study that are deemed desirable.

2. A typical program in marine ecology might follow the following steps.

   a. Advance information of the expectations and goals of the floating laboratory so that the classroom teacher may prepare the students.

   b. Departure from dock aboard boat with an introduction to the day's activities.

   c. Examination of an anchovy (Forage fish) by each student with special attention to physiological features.

   d. Circle previously set lines while the fathometer shows the topographical features beneath the sea.

   e. Pull set lines and put catch on to sorting table.

   f. Indicate difference in species.

   g. Have students sort species and examine internal organs and stomach contents.

   h. Circle previously set gill nets with fathometer to show habitat of surface feeding fish.

   i. Follow same procedure as used with set lines.

   j. Circle previously set crustacean traps and follow above procedure.

   k. Follow-up study program in classroom upon return for evaluation of findings and relationship to marine study.

3. With several sets of nets, traps, and setlines a good representative sampling of the inshore animal life could be assured and sample specimens for future study could be secured for the individual schools. The use of the fathometer to show feeding habits and examination of the physiological differences of the species to show particular adaptation to different habits will be a tremendous step in enriching the students knowledge of marine biology.

4. It is the intent of the pilot program to not limit its services to only college preparatory students. Students of all ability levels from the participating districts and schools will be encouraged to take advantage of the program.

5. It will be the responsibility of the participating district or school to provide transportation of its students to and from the dock from which the marine laboratory boat departs.

6. The Orange County Superintendent of Schools Office will act as scheduling coordinator and contact point for the districts and schools. The participating districts will make application to this office through the coordinator for science and secondary education. As many schools and classes as possible will be accomodated as time and facilities permit.

Objectives of the Floating Science Laboratory.

1. Utilize all possible talents and resources to develop an unusually valuable and meaningful educational experience for a broad segment of junior and senior high school youth.

2. Develop student appreciation and understanding of the sea, and life in the sea as a vast, largely untapped, natural resource.

3. Extend student awareness of the need to apply sound conservation practices in the use of the ocean and its many resources.

4. Provide students with a "hands-on" experience in the handling and use of scientific equipment related to the several branches of marine science.

5. Improve students' understanding for the need to bring the tools and concepts of many scientific disciplines to bear on the problem of investigating the secrets of the sea.

6. Assist students in the investigation of the educational and vocational opportunities associated with marine science.

7. Encourage the development of marine science as a permanent part of educational programs of participating schools and school districts.

8. Produce materials of instruction of district classroom use, K-12, for orientation, biological and physical science programs.

Evaluation

The ability to make the on board experience available to more than the original number of students ranks number one in results exceeding expectations. The original grant perspectus outlines the activities for some 5250 students from public and parochial schools in this county. However, because of many factors, the most notable being the acquisition of a superior vessel by means of going to public bid in the summer prior to commencing the program, the program was able to offer the marine science experience to over 8,000 students and 300 teachers.

Another result that exceeded the program expectation was in the publication of 11,000 copies of the Marine Science Student Syllabus. Through the cooperation of the County Schools Office, Division of Publications and the Audio Graphics Department, these volumes were ready and made available prior to October.

Another outstanding result of the program has been the production of a 21 minute, 16 mm color, sound film depicting the on board program. The total cost of the film was $2000.

Through the development of an extension program, making cruises available on Saturdays on a subscription basis to schools not participating in the normal program, an additional 800 students and teachers were able to share in the on board experiences.

The development of the Extension Program has enabled the Floating Laboratory to offer its services beyond the County. The extension program has allowed, therefore, the opportunity to lay the ground work for preliminary communications regarding joint power agreements for continuation of the program after federal assistance terminates.

Another result of the program that has exceeded expectations has been the development of an Onshore Laboratory. Through the cooperation of Davey's Locker, Inc. and the Ducommun Company a room was donated to the program for use as an Onshore Laboratory facility.

Davey's Locker negotiated with the Ducommun Company, owners of the Balboa Pavilion, and a room in the Balboa Pavilion was offered to the Floating Laboratory program. The program director feeling that the on board program was running smoothly made available the onshore facility to the county's schools. The schedule was filled two weeks after the general announcement was made. The onshore laboratory is therefore operated for the purpose of providing students who may not participate on the Floating

Laboratory an experience in the marine sciences. This operation is conducted at absolutely no cost to the program or the participating schools other than they are required to provide their own transportation. Over 1500 students will share this experience by the end of the year. The Floating Laboratory provides specimens for the onshore laboratory and the participating schools.

The one major problem of the program has been its inability to provide the experiences to more students.

Another area of concern that had not measured up to expectation is the teacher orientation program. The program with its small staff did not have the ability to do an adequate in-service or follow-up program development during the first semester.

This situation was slightly reduced during the second semester as a result of the program's development and the degree of impact from the exposure of over 150 teachers during the first semester. Their in-school assistance to teachers participating in the program has been tremendous.

4. Letters To Pace Directors

a. Introduction

Letter were drafted and sent to a carefully selected set of PACE Project Directors of science programs to obtain pertinent data to be included in the relevance guide and the relevance network. This data was requested from project directors throughout the United States to provide a comprehensive data collection.

The third level of the relevance network was the program level which was composed of the Mobile Science Laboratory Program and nine other programs selected out of all the projects received from these letters. Each program brochure received was analyzed to determine which ones most resembled the functions of the Mobile Science Laboratory Program. Ten were selected as options and included in the program level of the relevance network. Also, a comprehensive description of each program was included in the relevance guide to assist the voters in relevance assignment.

The MSL project director selected the project directors out of the 'Pacesetters in Innovation' summary. ALJ Associates, Inc. typed and forwarded the following letters to each director. The list of directors queried is also included.

MOBILE SCIENCE LABORATORY

Title III ESEA 89-10

Charles D. Carpenter
Brookside Jr. High School

DIRECTOR

SCHOOL DISTRICT No. 241
Albert Lea, Minnesota 56007

MOBILE SCIENCE LABOR...

September 27, 1968

Mr. Orien C. Shockley
Superintendent, Santa Fe Public Schools
Santa Fe, New Mexico 87501

Dear Mr. Shockley:

I have noted with great interest the description of your Outdoor Education Program recently described in the SEIAC Eric Newsletter of April 1968. I feel that information on your program, Cooperative Project to Provide Supplemental Services to a Group of Elementary and Secondary Schools of New Mexico, would help us on our Mobile Science Laboratory facility.

I would be interested in obtaining information concerning your program that you may have available, ie, copies of your proposal to OE and any descriptive materials. In addition, we would like your candid opinion of the effectiveness of the various aspects of your program. Do you feel that the original objectives of the first proposal are being attained? Have you implemented any changes in your program since the original proposal that have improved it?

We are presently in our third year of operation with the Mobile Science Laboratory facility. This Title III program is considering an evaluation program as a part of the last year's operation.

We have prepared two brochures on our own operational program and would be happy to provide copies of them to you if you so desire.

Sincerely yours,

Sample Letter

MOBILE SCIENCE LABORATORY

Title III ESEA 89-10

Charles D. Carpenter

Brookside Jr. High School

DIRECTOR

MOBILE SCIENCE LABORA

SCHOOL DISTRICT No. 241

Albert Lea, Minnesota 56007

September 27, 1968

Mr. James M. Riley, Coordinator
Multi-Media Instructional Center
1115 West Hillsboro
El Dorado, Arkansas 71730

Dear Mr. Riley:

I have noted with great interest the description of your Title III Education Program recently described in a PACESETTERS IN INNOVATION summary. I feel that information on your program, Multi-Media Instructional Center, would help us on our Mobile Science Laboratory facility.

I would be interested in obtaining information concerning your program that you may have available, ie, copies of your proposal to OE and any descriptive materials. In addition, we would like your candid opinion of the effectiveness of the various aspects of your program. Do you feel that the original objectives of the first proposal are being attained? Have you implemented any changes in your program since the original proposal that have improved it?

We are presently in our third year of operation with the Mobile Science Laboratory facility. This Title III program is considering an evaluation program as a part of the last year's operation.

We have prepared two brochures on our own operational program and would be happy to provide copies of them to you if you so desire.

Sincerely yours,

Sample Letter

b. Mailing List of Project Directors

Mr. Harold L. Coles, County Superintendent of Schools
Central California Laboratory for Learning-Extension
2314 Mariposa Street
Fresno, California 93721

Mr. J. Win Payne, Superindendent
Experimental Forest
Napa Valley Unified School District
1750 First Street
Napa, California 94558

Mr. Blaine Wishart, Executive Director
Superior California Educational Resources Agency
1854 Fulton Avenue
Sacramento, California 95825

Mr. Charles R. Baker, Director
Conservation, Recreation and Outdoor Science School (Project CROSS)
Pupil Personnel Service and School Psychologist
P. O. Box 518
San Andreas, California 95249

Mr. Wesley D. Gordon, Coordinator of Science
Natural History Museum and Research Center
San Lorenzo Unified School District
15510 Usher Street
San Lorenzo, California 94580

Mr. F. A. Grunefelder
Orange County Superintendent of Schools Office
1104 West Eighth Street
Santa Ana, California 92700

Mr. Gaylord A. Nelson
Northern San Joaquin Valley Counties
Supplementary Education Center
222 East Weber Avenue
Stockton, California 95202

Mr. Roy G. Brubacher, Executive Director
Cooperative Summer School Camp
San Luis Valley Board of Cooperative Services
Alamosa, Colorado 81101

Mr. Roy G. Brubacher, Consultant
Cooperative Summer School Camp
Boards of Cooperative Services
Adams State College
Alamosa, Colorado 81101

Mr. John G. Stuart, Superintendent
Adams County School District 14
4720 East 69th Avenue
Commerce City, Colorado 80022

Mr. Donald P. LaSalle, Science Coordinator
Talcott Ridge Science Center for Student Involvement
Avon Board of Education
Avon Junior-Senior High School
West Avon Road
Avon, Connecticut 06001

Mr. C. Fred Graef, Chief School Officer
Pilot Nature Center Program
Greenwood Consolidated School, No. 91
Greenwood, Delaware 19950

Mr. Wilmer E. Shue, Superintendent of Schools
Outdoor Laboratory
83 East Main Street
Newark, Delaware 19711

Mr. Buford H. Galloway
Superintendent of Public Instruction
Columbia County Board of Public Instruction
P. O. Box 1148
Lake City, Florida 32055

Mr. James E. Hall
Superintendent of Public Instruction
Escambia-Santa Rosa Humanities Curriculum Center
P. O. Box 1470
Pensacola, Florida 32502

Mr. Alan E. Hart
Superintendent of Public Instruction
Resource-Use Outdoor Education Center
Taylor County Board of Public Instruction
P. O. Box 509
Perry, Florida 32347

Dr. Thomas W. Gulford
Superintendent of Public Instruction
Sarasota County Educational Enrichment Centers
2418 Halton Street
Sarasota, Florida 33577

Dr. Lewis Shelton
Fernbank Science Center
DeKalb College
555 N. Indian Creek Road
Clarkson, Georgia 30021

Mr. William Thomas, District Superintendent
827 Fort Hall Avenue
American Falls, Idaho 83211

Mr. S. Clay Coy
Superintendent of Schools
School District #271
118 North Seventh Street
Coeur D' Alene, Idaho 83814

Mr. Corbyn Hamby, Superintendent
School District No. 47
27 North Main Street
Crystal Lake, Illinois 60014

Mrs. Beverly H. Southern
Littlejohn School
Dekalb, Illinois 60115

Mr. Orland Stanley, Superintendent of Schools
Community Unit School District No. 2
1410 West Hendrickson Street
Marion, Illinois 62959

Mr. E. S. Castor, Superintendent
Community Consolidated School District 15
Washington Court
Palatine, Illinois 60067

Mr. Lee R. Gilbert, Superintendent
Community School Corporation
620 East 10th Place
Gary, Indiana 46402

Mr. S. W. Wiley, Superintendent of Schools
College Community Schools
R. R. #2
Cedar Rapids, Iowa 52404

Mr. Frank Colaw, Superintendent of Schools
Unified School District #345
1124 West Lyman Road
Topeka, Kansas 66601

Mr. Emmett Cope, Superintendent
P. O. Box 218
Benton, Louisiana 71006

Mr. L. H. Boulet, Superintendent
305 Washington Street
St. Martinville, Louisiana 70582

Mr. Stanley W. Wright, Superintendent of Schools
RFD #1
South Windham, Maine 04082

Mr. John E. Yingling
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Mr. Haskell Smith
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Bayard, New Mexico 80023

Mrs. Nell Rogers Croley
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C. Computer Application

1. Introduction

This computer section defines the computer program input/output system used on the subject contract. The complete input/output technique is delineated in the I/O flowchart. An example set of data listings is shown for each phase of the program.

2. Input/output Flowchart Description

The computerized evaluation methodology can be divided into three distinct phases:

The first phase, as shown in Figure C-1, consists of programs 'FT 01, 'FT 02', 'FT 205' and 'FT 03'. The input to the first program is option and criterion data. The program converts the input data to magnetic tape records and computes level numbers from the coded options.

The records are sorted sequentially on the first twenty nine positions which are the criterion number, option code, card code and the level number respectively. The tape-records are then inputed to 'FT 02. 'FT 02' combines the code 1 and 2 records and merges the criterion record data with the appropriate option record data creating a new tape file. The 'FT 02' tape records are sorted on the first twenty-seven positions which are the level number, option ID, card code and the criterion number respectively. 'FT 205' performs a file maintenance on the output records of 'FT 02' and the records are then inputed to 'FT 03'. 'FT 03' produces the blank ballot matrices used to assign relevance numbers.

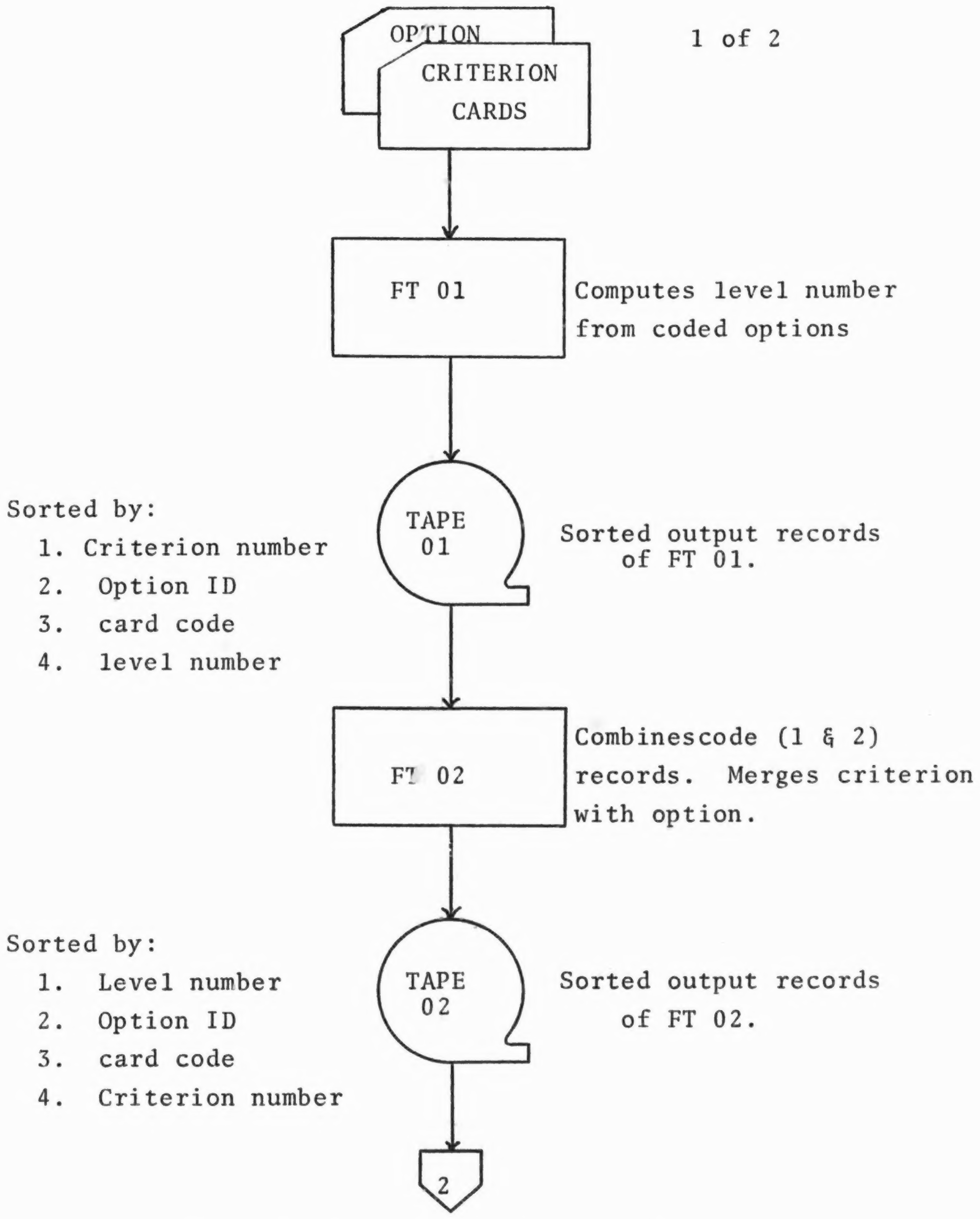
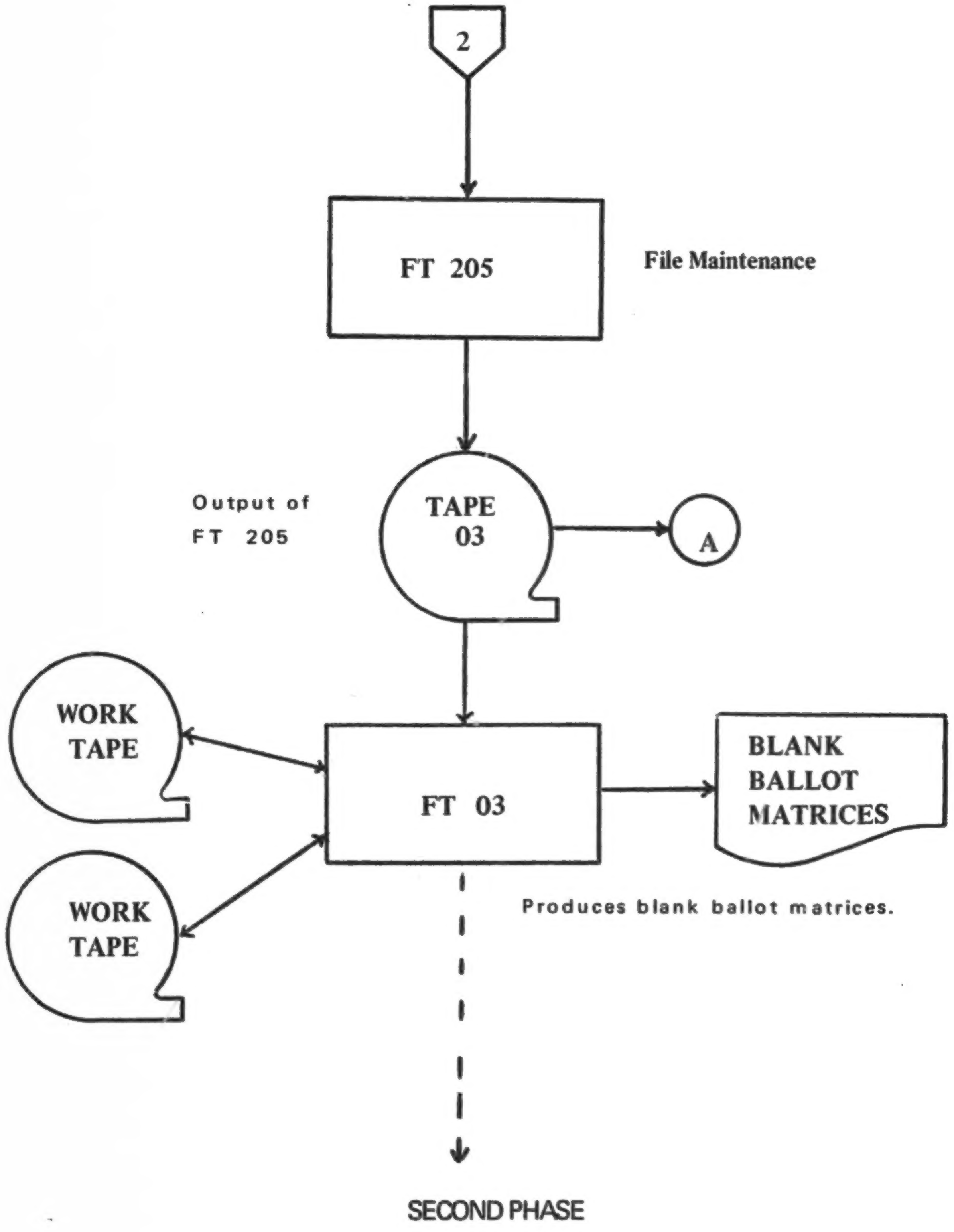

1 of 2
OPTION
CRITERION
CARDS
FT 01
Computes level number from coded options
TAPE 01
Sorted output records of FT 01.
Sorted by:
1. Criterion number
2. Option ID
3. card code
4. level number
FT 02
Combinescode (1 & 2) records. Merges criterion with option.
TAPE 02
Sorted output records of FT 02.
Sorted by:
1. Level number
2. Option ID
3. card code
4. Criterion number
2

Figure C-1. Input/Output Flowchart, Phase I


2
FT 205
TAPE 03
A
WORK TAPE
WORK TAPE
FT 03
BLANK BALLOT MATRICES
SECOND PHASE

File Maintenance

Output of FT 205

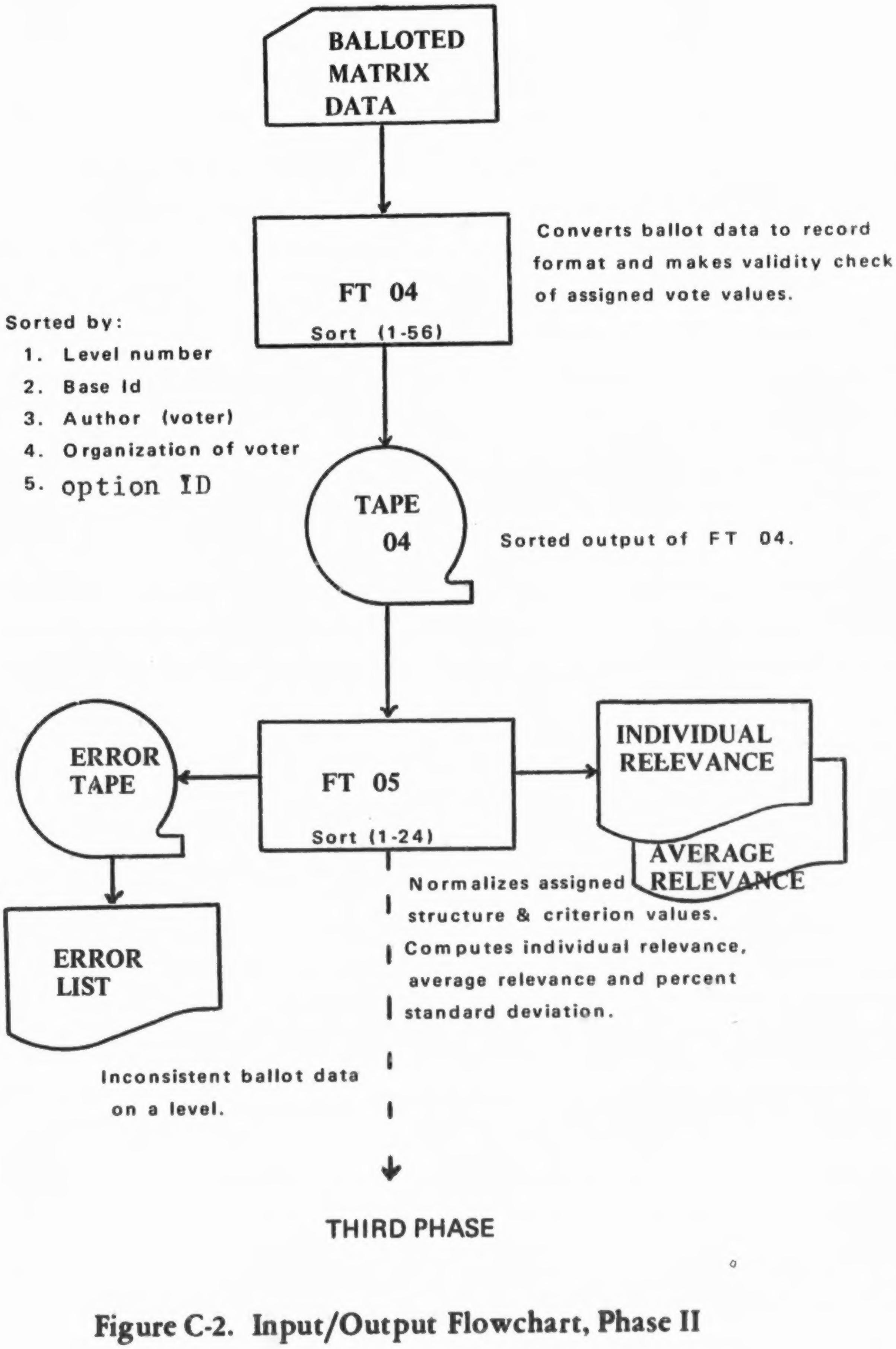
Produces blank ballot matrices.

The second phase, as shown in Figure C-2, consists of programs 'FT 04' and 'FT 05. 'FT 04' performs a validity check of the assigned ballot relevance data and converts the data into the proper format for the output tape records. The output tape-records are then sorted on the first fifty-six positions which include the level number, base ID, voters initials, voter organization, and the option ID. The tape-records then become the input to 'FT 05'. 'FT 05' normalizes the assigned option and criterion values, computes Individual and Average Relevance and the Percent Standard Deviation. Individual and Average Relevance and the Percent Standard Deviation are outputed in printed listings. The program also, produces a tape-file that is sorted on the first twenty-four positions which are the level number and the option ID.

The third phase, as shown in Figure C-3, consists of the programs 'FT 06, 'FT 07' and 'FT 08. 'FT 06' computes the Branch Relevance and creates the BR file. The BR file is the file used to maintain the Branch Relevance records. The BR records are sorted on the first twenty-nine positions which are the level number, Branch Relevance field and the ID code and inputed to 'FT 07'. 'FT 07' ranks the elements in two formats first by relevance and then by ID, and creates an output tape-file. The output tape-file records are sorted on the first twenty-nine positions which are the format code, level number and the relevance-ID field. The records are then inputed to 'FT 08' which produces the Branch Relevance listings.

3. Representative Computer Outputs

The first output of the computer programming system is Blank Ballot Matrices used by the students and educators in assigning


BALLOTED MATRIX DATA
FT 04
Sort (1-56)
TAPE 04
FT 05
Sort (1-24)
ERROR TAPE
ERROR LIST
INDIVIDUAL RELEVANCE
AVERAGE RELEVANCE
THIRD PHASE

Converts ballot data to record format and makes validity check of assigned vote values.

Sorted by:
1. Level number
2. Base Id
3. Author (voter)
4. Organization of voter
5. option ID

Sorted output of FT 04.

Normalizes assigned structure & criterion values. Computes individual relevance, average relevance and percent standard deviation.

Inconsistent ballot data on a level.

Figure C-2. Input/Output Flowchart, Phase II

1 of 2

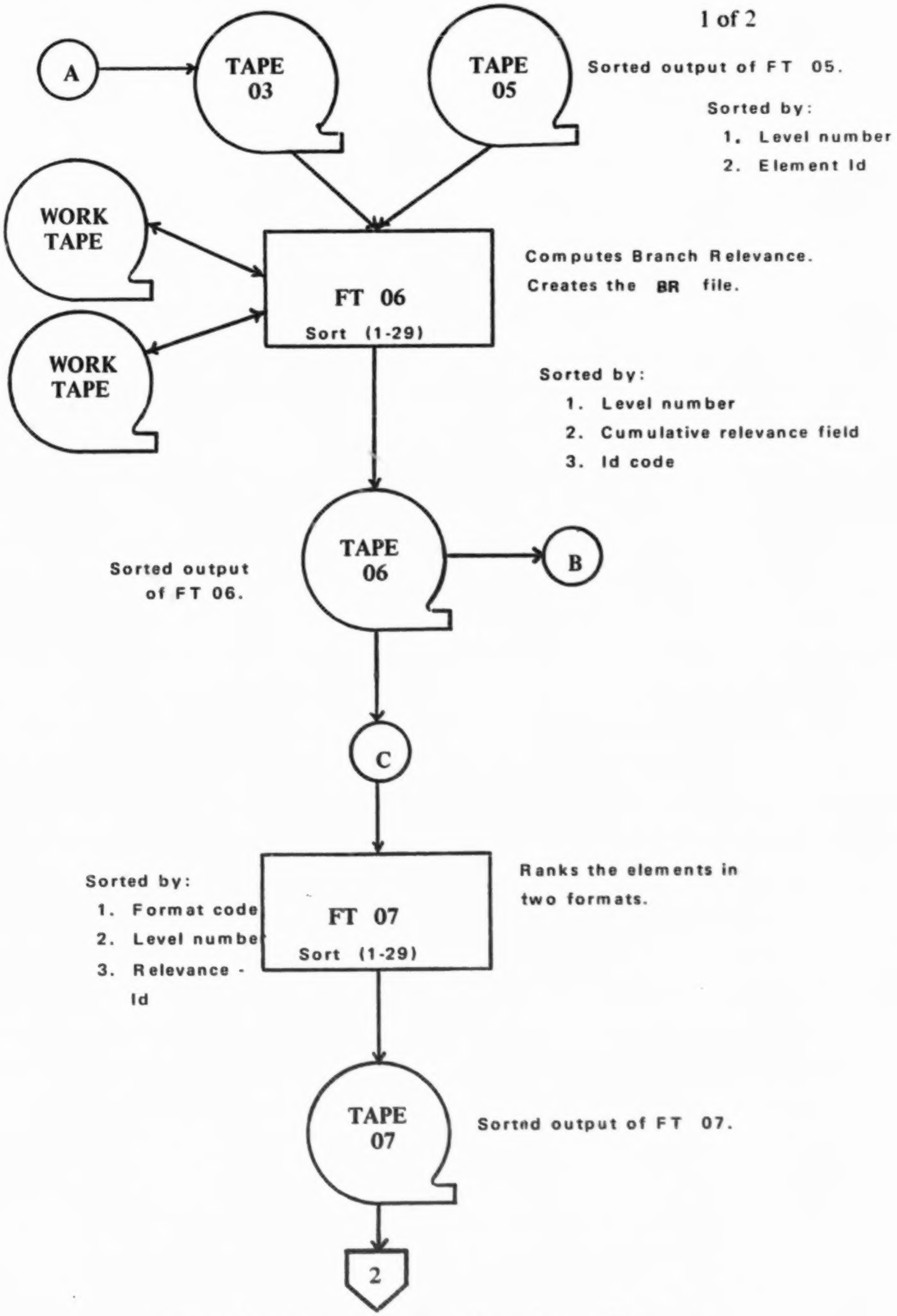
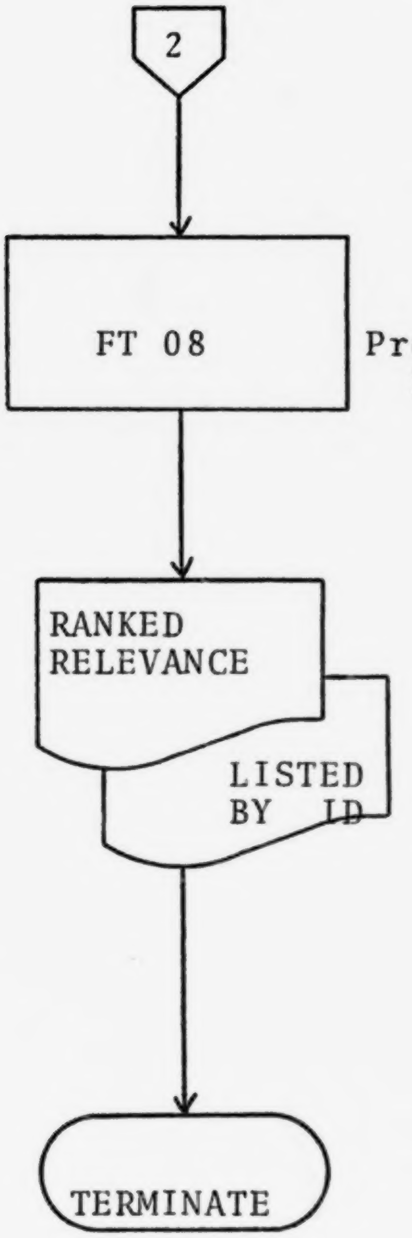

A
TAPE 03
TAPE 05
Sorted output of FT 05.
Sorted by:
1. Level number
2. Element Id
WORK TAPE
WORK TAPE
FT 06
Sort (1-29)
Computes Branch Relevance.
Creates the BR file.
Sorted by:
1. Level number
2. Cumulative relevance field
3. Id code
TAPE 06
Sorted output of FT 06.
B
C
Sorted by:
1. Format code
2. Level numbe
3. Relevance - Id
FT 07
Sort (1-29)
Ranks the elements in two formats.
TAPE 07
Sortnd output of FT 07.
2

Figure C-3. Input/Output Flowchart, Phase III

2 of 2


2
FT 08
RANKED RELEVANCE
LISTED BY ID
TERMINATE

Produces printed listings.

4

option and criterion values. Figure C-4 is an example of a ballot printed by the computer for the Mobile Science Laboratory Evaluation. The title at the top of the ballot reflects the node of interest. The ID's and titles under the node title are representative of the options to the node. Along the top of the matrix are the criterion ID's, under each a criterion value is placed when balloting the node. Below the criterion weight row on the left column are the ID's reflecting the options which are also, assigned values for each criterion. Values are assigned by team members in sets. A set consists of the complete criterion row (left to right) or a column (up and down) of values below each assigned criterion weight. The values can be inserted in three formats as long as they are uniform on each individual ballot. The value can be in the format of (x.x), (xx.), or (.xx). The program will handle all three formats and normalize to unity in 'FT 05'. Below the matrix are the criteria ID's with their appropriate titles to aid the voter in identifying the criteria when assigning values to the options.

The second type of output listing of the PATTERN system is the Individual Relevance, Average Relevance and Percent Standard Deviation. Figure C-5 is an example of an Individual Relevance listing. The listing is composed of a heading, Individual Relevance Matrix, Name and Organization of the voter. Under the headings are the criterion weights normalized, by row, to unity by the computer. Below the criterion values, on the left margin, are the option ID's, the center columns are the individual assigned relevances normalized, by column, to unity. The right-most column of values is the Individual Node Relevances.

```
1AC1                     MOBILE SCIENCE LABORATORY              NAME
                                                                ORG.

1A01F1                   ELEMENTARY USES
1A01F2                   SECCNDARY USES
1A01F3                   TEACHER USES
1A01F4                   COMMUNITY USES

           CRITERIA ID /  26  /  27  /  28  /  29  /      /      /      /      /
                       /------/------/------/------/------/------/------/------/
           CRITERIA WT /      /      /      /      /      /      /      /      /
                       /------/------/------/------/------/------/------/------/
1A01F1                 /      /      /      /      /      /      /      /      /
                       /------/------/------/------/------/------/------/------/
1A01F2                 /      /      /      /      /      /      /      /      /
                       /------/------/------/------/------/------/------/------/
1A01F3                 /      /      /      /      /      /      /      /      /
                       /------/------/------/------/------/------/------/------/
1A01F4                 /      /      /      /      /      /      /      /      /
                       /------/------/------/------/------/------/------/------/
 CRITERIA 26  PARTICIPANTS
          27  FACILITIES
          28  FULFILL 241 SCIENCE EDUCATICNAL REQUIREMENTS
          29  PROVIDE NEW AND INCREASED OPPORTUNTIES
```

Figure C-4. Sample Ballot Form

```
                              INDIVIDUAL  RELEVANCE  MATRIX                 NAME-SRB
                                                                            ORG.-SJR

          CRITERIA WT.   .30   .15   .20   .35


1A01                     .17   .10   .10   .16                              .142000
1A02                     .07   .10   .10   .08                              .084000
1A03                     .14   .10   .10   .13                              .122500
1A04                     .15   .10   .10   .14                              .129000
1A05                     .12   .10   .10   .11                              .109500
1A06                     .11   .10   .10   .09                              .099500
1A07                     .07   .10   .10   .06                              .077000
1A08                     .08   .10   .10   .08                              .087000
1A09                     .05   .10   .10   .06                              .071000
1A10                     .04   .10   .10   .09                              .078500
```

Figure C-5. Sample Individual Relevance Node Listing

Figure C-6 is an example of an Average Relevance and Percent Standard Deviation listing. The listing is composed of the heading, Average Relevance Matrix below which are the option ID's, the Average Relevances and the Percents Standard Deviation respectively.

The Individual and Average Relevance output listings are used by the evaluation team to determine agreement of individual balloting at a node. The Percent Standard Deviation reveals the actual degree of agreement and aids in determining problem areas in either option or criterion linkage to the overall relevance network.

The third output listing of the PATTERN system is the Ranked Branch Relevance listings, produced by the Branch Relevance Phase. The listings are printed by the computer in two formats. The first format as shown in Figure C-7 is a listing of option ID's and Titles ranked according to the Branch Relevance number. The second format, Figure C-8 is a listing of option titles and Branch Relevance numbers according to ID. The listings are utilized by the evaluation team for analysis and data files.

```
                                          AVERAGED    RELEVANCE  MATRIX

          CRITERIA WT.

 1A01                                                                .161576     15.33
 1A02                                                                .083750     20.76
 1A03                                                                .128226     10.30
 1A04                                                                .111950     14.43
 1A05                                                                .099383     19.28
 1A06                                                                .105792     13.97
 1A07                                                                .079614     19.37
 1A08                                                                .077609     20.60
 1A09                                                                .075590     18.34
 1A10                                                                .076505     22.03
```

Figure C-6. Sample Average Relevance and Percent Standard Deviation Listing

```
              TOTAL DIRECT RELEVANCE OF THE PLAN-IMPL-ANAL
 RANKED BY RELEVANCE NUMBER (HIGH TO LOW)
RANK       ID                                   TITLE                                         RELEVANCE

0001 1A01F2304310A1          PLANNING                                                   0.0141059
0002 1A01F2304433B1          IMPLEMENTATION                                             0.0116614
0003 1A01F2304408A1          PLANNING                                                   0.0103147
0004 1A01F2302333A1          PLANNING                                                   0.0097294
0005 1A01F2305418A1          PLANNING                                                   0.0094935
0006 1A01F2305418B1          IMPLEMENTATION                                             0.0094935
0007 1A01F2304433A1          PLANNING                                                   0.0094465
0008 1A01F2304408B1          IMPLEMENTATION                                             0.0093030
0009 1A01F2306328A1          PLANNING                                                   0.0092480
0010 1A01F2305401B1          IMPLEMENTATION                                             0.0091569
0011 1A01F2301412A1          PLANNING                                                   0.0091053
0012 1A01F2304408C1          ANALYSIS                                                   0.0091051
0013 1A01F2302417A1          PLANNING                                                   0.0089494
0014 1A01F2305415A1          PLANNING                                                   0.0087912
0015 1A01F2305415B1          IMPLEMENTATION                                             0.0087012
0016 1A01F2302417B1          IMPLEMENTATION                                             0.0086591
0017 1A01F2305327B1          IMPLEMENTATION                                             0.0084839
0018 1A01F2302417C1          ANALYSIS                                                   0.0081915
0019 1A01F2305231A1          PLANNING                                                   0.0081843
0020 1A01F2305419B1          IMPLEMENTATION                                             0.0080693
0021 1A01F2304433C1          ANALYSIS                                                   0.0077406
0022 1A01F2306232A1          PLANNING                                                   0.0076132
0023 1A01F2301414A1          PLANNING                                                   0.0073721
0024 1A01F2304427B1          MPLEMENTATION                                              0.0073138
0025 1A01F2305415C1          ANALYSIS                                                   0.0073099
0026 1A01F2307406C1          ANALYSIS                                                   0.0072885
0027 1A01F2306328C1          ANALYSIS                                                   0.0072867
0028 1A01F2301412B1          IMPLEMENTATION                                             0.0072854
0029 1A01F2307406A1          PLANNING                                                   0.0072485
0030 1A01F2305231B1          IMPLEMENTATION                                             0.0072315
0031 1A01F2307406B1          IMPLEMENTATION                                             0.0067822
0032 1A01F2304309A1          PLANNING                                                   0.0065930
0033 1A01F2304427A1          PLANNING                                                   0.0065753
0034 1A01F2302403C1          ANALYSIS                                                   0.0065415
0035 1A01F2301412C1          ANALYSIS                                                   0.0064296
0036 1A01F2304339A1          PLANNING                                                   0.0063183
```

Figure C-7. Sample Listing of PIA Ranked By Relevance

```
           TOTAL DIRECT RELEVANCE OF THE PLAN-IMPL-ANAL
 LISTED BY IDENTIFICATION CODE (LOW TO HIGH)
    ID                                  TITLE                                           RANK RELEVANCE

1A01F2108105A1          PLANNING                                                        0153 0.0026915
1A01F2108105B1          IMPLEMENTATION                                                  0150 0.0027063
1A01F2108105C1          ANALYSIS                                                        0148 0.0027246
1A01F2108109A1          PLANNING                                                        0164 0.0025801
1A01F2108109B1          IMPLEMENTATION                                                  0168 0.0025436
1A01F2108109C1          ANALYSIS                                                        0176 0.0024863
1A01F2108118A1          PLANNING                                                        0143 0.0028977
1A01F2108118B1          IMPLEMENTATION                                                  0201 0.0019846
1A01F2108118C1          ANALYSIS                                                        0219 0.0017435
1A01F2108204A1          PLANNING                                                        0179 0.0024131
1A01F2108204B1          IMPLEMENTATION                                                  0182 0.0023490
1A01F2108204C1          ANALYSIS                                                        0166 0.0025586
1A01F2108224A1          PLANNING                                                        0206 0.0019428
1A01F2108224B1          IMPLEMENTATION                                                  0262 0.0007341
1A01F2108224C1          ANALYSIS                                                        0263 0.0007210
1A01F2108308A1          PLANNING                                                        0175 0.0024916
1A01F2108308B1          IMPLEMENTATION                                                  0167 0.0025441
1A01F2108308C1          ANALYSIS                                                        0160 0.0026101
1A01F2108316A1          PLANNING                                                        0187 0.0021858
1A01F2108316B1          IMPLEMENTATION                                                  0195 0.0020864
1A01F2108316C1          ANALYSIS                                                        0248 0.0010841
1A01F2108325A1          PLANNING                                                        0066 0.0046248
1A01F2108325B1          IMPLEMENTATION                                                  0229 0.0014627
1A01F2108325C1          ANALYSIS                                                        0286 0.0003411
1A01F2108331A1          PLANNING                                                        0097 0.0038402
1A01F2108331B1          IMPLEMENTATION                                                  0284 0.0003491
1A01F2108331C1          ANALYSIS                                                        0282 0.0003891
1A01F2108337A1          PLANNING                                                        0255 0.0009354
1A01F2108337B1          IMPLEMENTATION                                                  0158 0.0026549
1A01F2108337C1          ANALYSIS                                                        0293 0.0000779
1A01F2108410A1          PLANNING                                                        0151 0.0026994
1A01F2108410B1          IMPLEMENTATION                                                  0137 0.0030906
1A01F2108410C1          ANALYSIS                                                        0211 0.0018624
1A01F2108421A1          PLANNING                                                        0177 0.0024767
1A01F2108421B1          IMPLEMENTATION                                                  0172 0.0025123
1A01F2108421C1          ANALYSIS                                                        0173 0.0025020
```

Figure C-8. Sample Listing of PIA Ranked By ID

D. Student Project Cards

1. Introduction

Four types of data gathering cards were designed to assist the students in organizing in detail the entirety of their projects as well as to assure maximum compatibility of data collected with the Mobile Science program's evaluation methodology. The four types of cards, (1) Project Summary Card, (2) Project Description Card, (3) Supporting Data Card and (4) Criteria card were designed prior to the 1968 summer program for student use in collecting data. Cards were used instead of paper to facilitate data collection in the field.

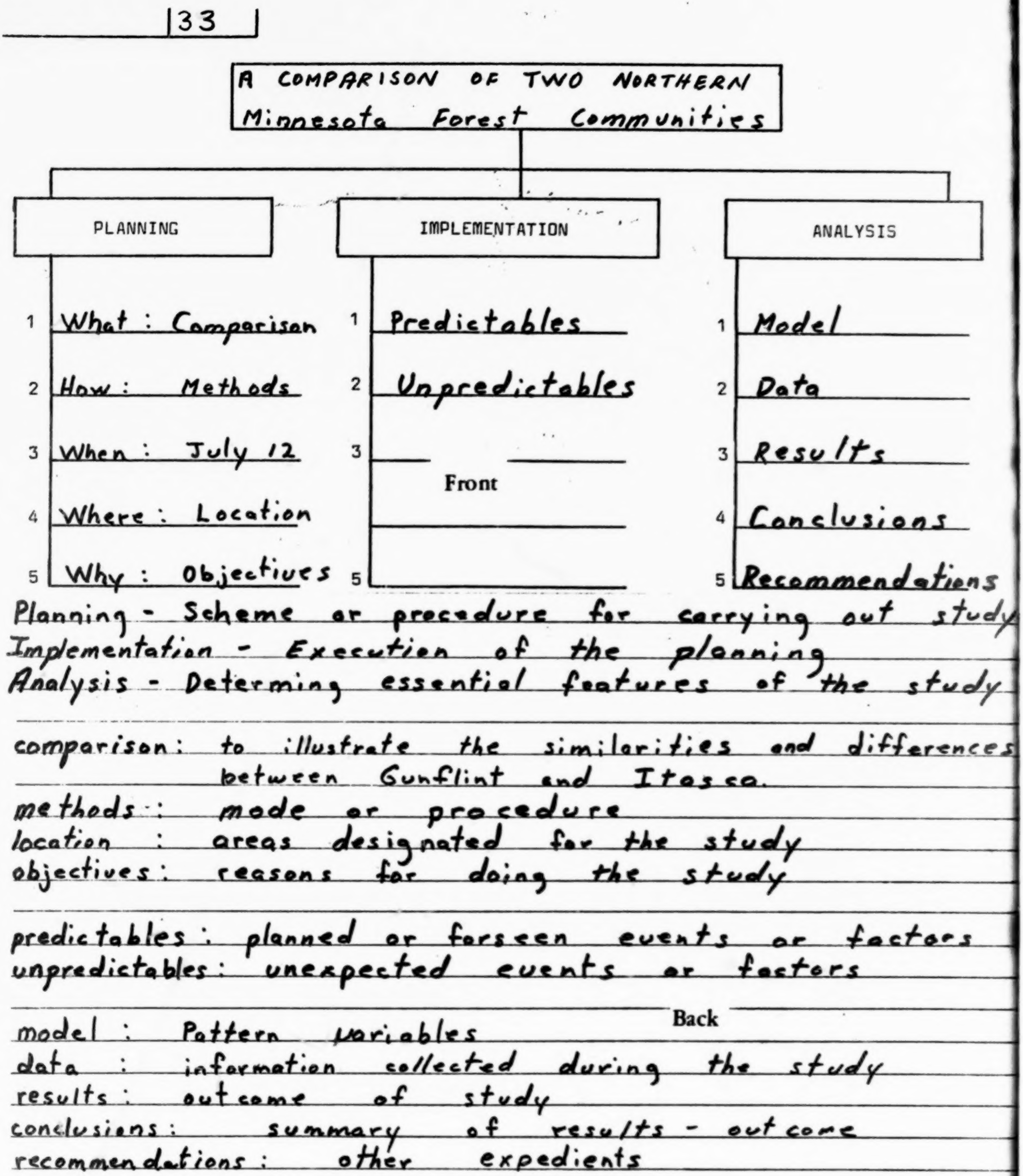
This section explains the rationale for use of each type of card, the disposition of data on the cards, the problems arising in use of the cards, and the recommendations for future card usage.

2. Project Summary Card

The Project Summary Card as shown in Figure D-1 is an abstract of the students project. There is one Project Summary Card for each project. The front of the card is pre-printed and is used to define the broad concepts of the project in outline format. The project number is placed in the upper left corner and the title in the center under the project number. The pre-printed information are the column headings: planning, implementation and analysis.

Planning is subdivided into five sections: what, how, when, where, and why. The planning part of the outline is designed to help the student organize completely all his thoughts and ideas about his anticipated modus operandi.

Implementation is subdivided into predictables and unpredictables as a minimum, plus any other pertinent data selected by the student. The implementation part is designed to record expected



33

A COMPARISON OF TWO NORTHERN Minnesota Forest Communities

	PLANNING		IMPLEMENTATION		ANALYSIS
1	What : Comparison	1	Predictables	1	Model
2	How : Methods	2	Unpredictables	2	Data
3	When : July 12	3		3	Results
4	Where : Location			4	Conclusions
5	Why : Objectives	5		5	Recommendations

Front

Planning - Scheme or procedure for carrying out study
Implementation - Execution of the planning
Analysis - Determing essential features of the study

comparison: to illustrate the similarities and differences between Gunflint and Itasca.
methods : mode or procedure
location : areas designated for the study
objectives : reasons for doing the study

predictables : planned or forseen events or factors
unpredictables : unexpected events or factors

Back

model : Pattern variables
data : information collected during the study
results : outcome of study
conclusions : summary of results - outcome
recommendations : other expedients

Figure D-1. Project Summary Card

and unexpected happenings while on the field trip.

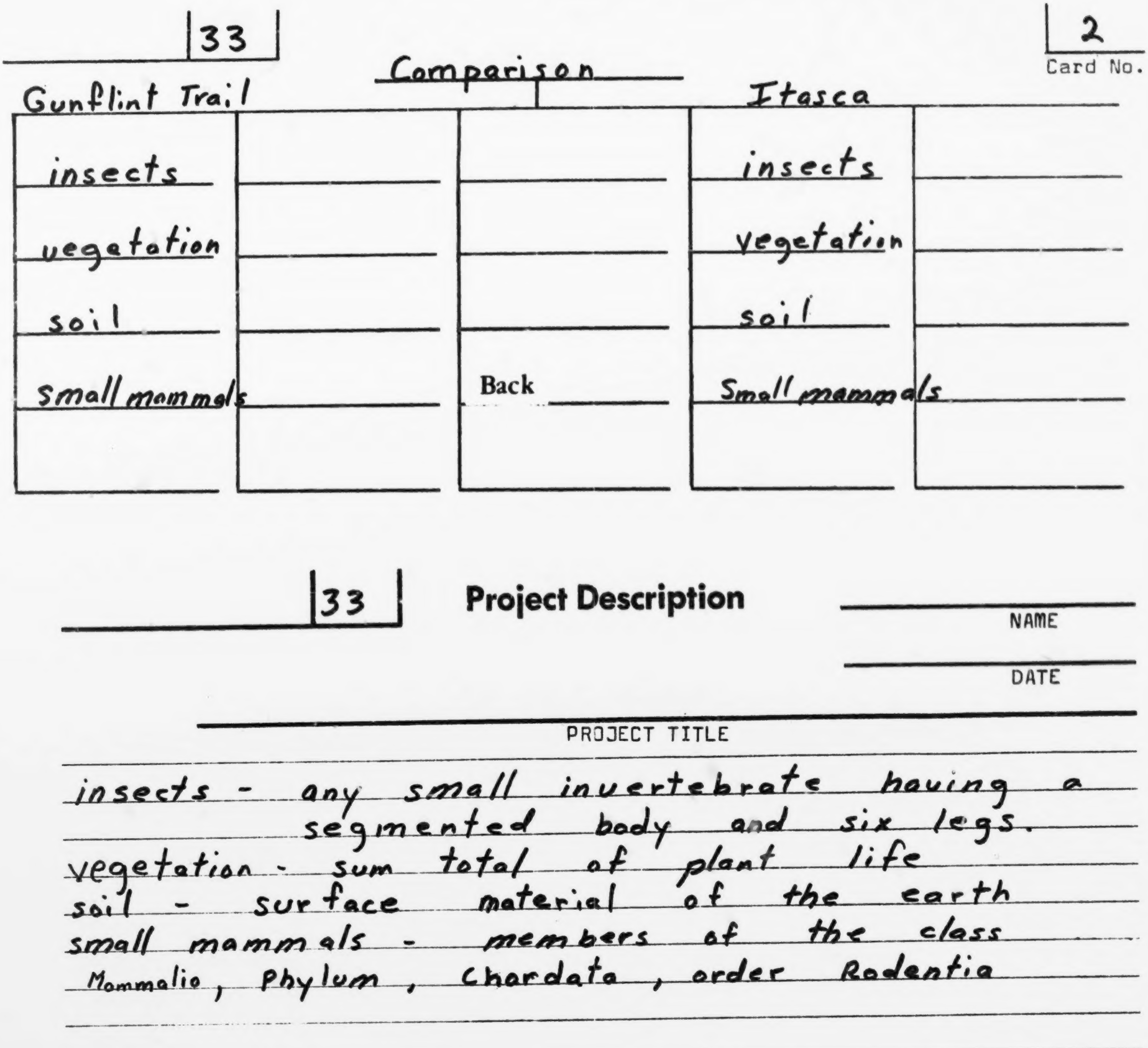
Analysis also consists of five subdivisions: model, data results, conclusions, and recommendations. The model is a definition or identification of the student selected variables. The data are the analysis of all relevant material collected, irrelevant data are deleted. The results include appropriate graphs, charts and comparisons with description and application. The conclusions specify whether the project supported planned objectives and projections, dissents, or is inconclusive in nature. The recommendations reveal new ideologies for future projects as well as criticisms of past program experiences.

The back of the card is used for a short description or summary of the planned aspects of the project. The back of the card is also used to define or continue the elements of the outline on the front side.

3. Project Description Card

The Project Description Card as shown in Figure D-2 is similar in format to the Project Summary Card. This card is used to further sub-divide the outline elements of the Project Summary Card and also to further sub-divide other Project Description Cards. The main purpose of this card is to try to get the student to break down every element in his or her outline to their smallest component parts and be aware of their interrelatedness. The cards are also of benefit in developing in the students a systematic approach to research and study.

There can be as many Project Description Cards as a student deems necessary or appropriate to sub-divide his or her project into its component parts. The planning, implementation, and analysis are the only three given categories of project outline. The students own motivation dictates the extent of outline



33

Comparison

2
Card No.

Gunflint Trail			Itasca	
insects			insects	
vegetation			vegetation	
soil			soil	
small mammals		Back	Small mammals	

33 **Project Description**

NAME

DATE

PROJECT TITLE

insects - any small invertebrate having a segmented body and six legs.
vegetation - sum total of plant life
soil - surface material of the earth
small mammals - members of the class Mammalia, Phylum, Chordata, order Rodentia

Front

Figure D-2. Project Description Card

element breakdown.

4. Support Data Card

The Supporting Data Card as shown in Figure D-3 is used to record data that supports, defines, or compliments outline elements on the Project Description Cards. All data collected that does not lend itself to outline format such as charts, graphs, diagrams, and application explanation are recorded on these cards. There can be as many Supporting Data Cards used as a student wishes to record the data pertinent to his or her project.

5. Criteria Card

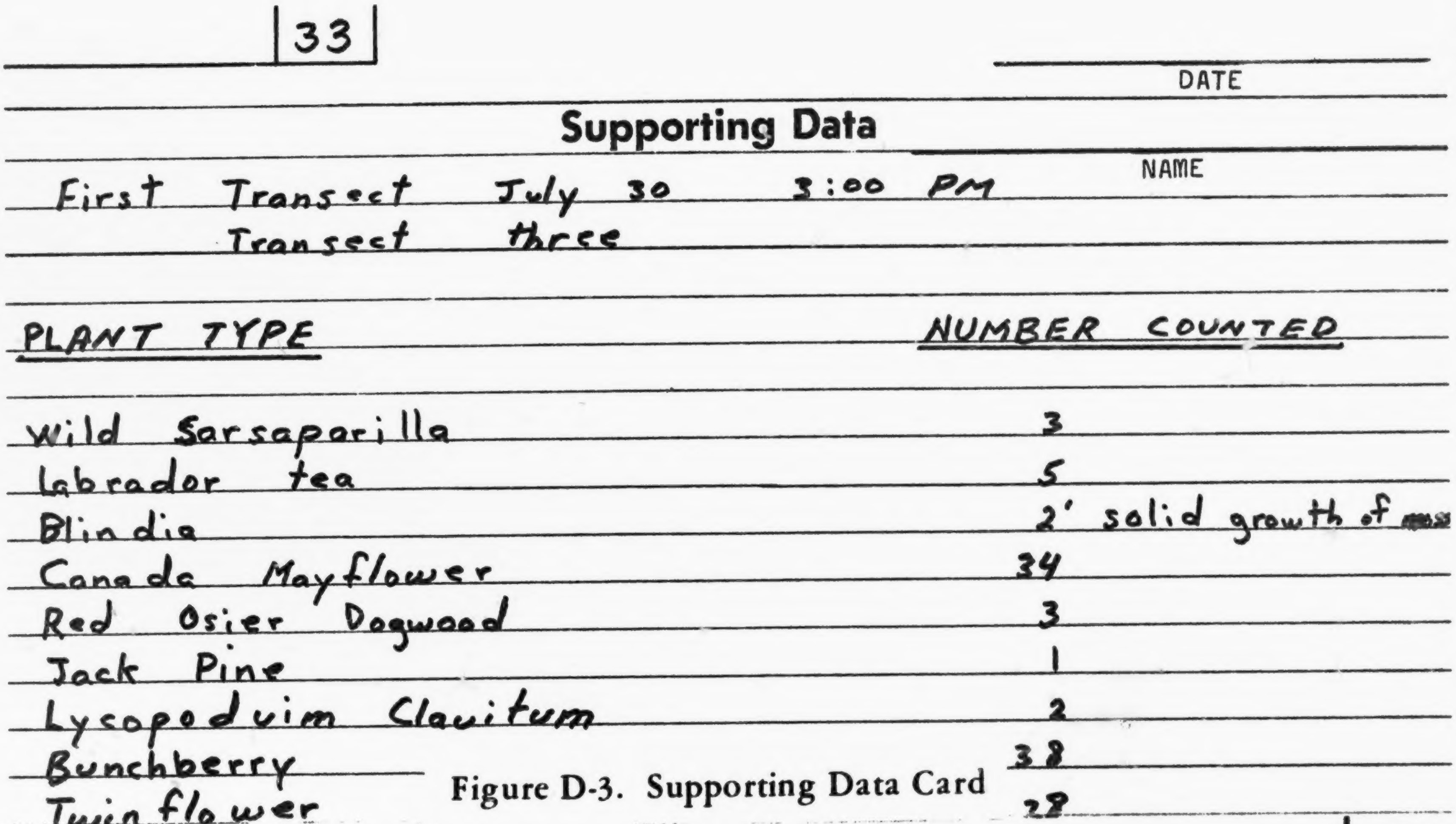
The Criteria Card as shown in Figure D-4 is used to record the students reasons for doing each part of his or her project. This card works directly with the Project Description Card in that while the student is developing a systematic approach to research, he is also recording the reasons for each and every step.

The criteria cards are benefical to the students in that many times after careful consideration, they find easier methods of program accomplishment. In other instances, they feel they wasted time in the field or that they were not properly prepared.

The educators benefit also from the criteria cards in that they are better able to evaluate the student's project when they know exactly how and why the student performed.

6. Coding of Cards

Considerable effort and time were spent coding (assigning representative alpha-numeric characters) each element of the project outline. The elements on the project outline are coded to assure compatability with the computer program aspect of the



33

DATE

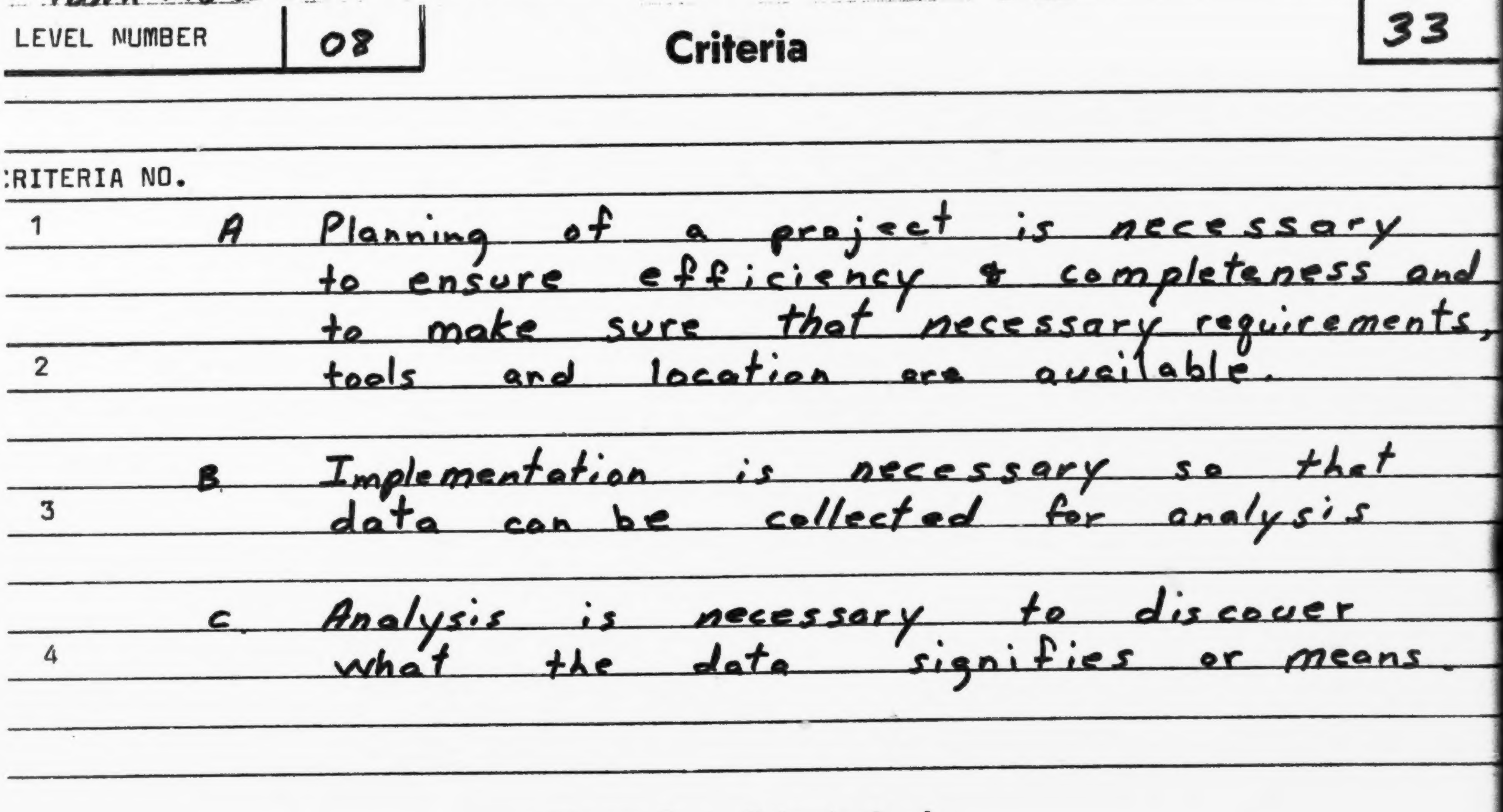
Supporting Data

NAME

First Transect July 30 3:00 PM
Transect three

PLANT TYPE	NUMBER COUNTED
Wild Sarsaparilla	3
labrador tea	5
Blindia	2' solid growth of [illegible]
Canada Mayflower	34
Red Osier Dogwood	3
Jack Pine	1
Lycopoduim Clauitum	2
Bunchberry	38
Twinflower	28

Figure D-3. Supporting Data Card



LEVEL NUMBER 08

Criteria

33

CRITERIA NO.

1 A Planning of a project is necessary to ensure efficiency & completeness and to make sure that necessary requirements,
2 tools and location are available.

B Implementation is necessary so that
3 data can be collected for analysis

C. Analysis is necessary to discover
4 what the data signifies or means.

Figure D-4. Criteria Card

evaluation methodology.

The computer program identifies each element of the outline network by a particular code. Planning is an A code, Implementation is a B code, and Analysis is a C code. Under planning A1 equals what, A2 equals how, A3 equals when, A4 equals where, and A5 equals why. The next element outline breakdown under A1 would be A11 which would subdivide into A111 and so on for each outline element of the what under planning. The same method of coding is used for implementation and analysis. Each subsequent element in a category uses as the base for its code, the code of the preceeding element.

Figures D-5 and D-6 are a coded Project Summary Card and Project Description Card from project 33, "A Comparison of Two Northern Minnesota Forest Communities", as coded 1A01F2304433. The code means: Extended Equipment or Technique (1), In the Science area (1A). Using the Mobile Science Laboratory (1A01), At the Secondary Education level (1A01F2), In the Life Science Curriculum (1A01F23), Project assigned to the 4th group (1A01F2304), Student having participated in the MSL program four years and the project number 33 (1A01F230433). Each subsequent breakdown uses as the base for its code, the code of the preceeding option. The code (1A01F230433) is a base for each outline element breakdown of project 33. For example, 1A01F230433B2 represents unpredictables in project 33, and 1A01F230433C4 represents conclusions, and 1A01F230433C41 represents the next subsequent element in conclusions, etc.

7. Method of Conversion to Tape

The data collected on cards in the field by the students were typed and formated for magnetic tape storage. The reason the data were put on magnetic tape was for IBM MT/ST utilization. The MT/ST records all the typed data on magnetic tape and will play it back automatically. All corrections, deletions, or

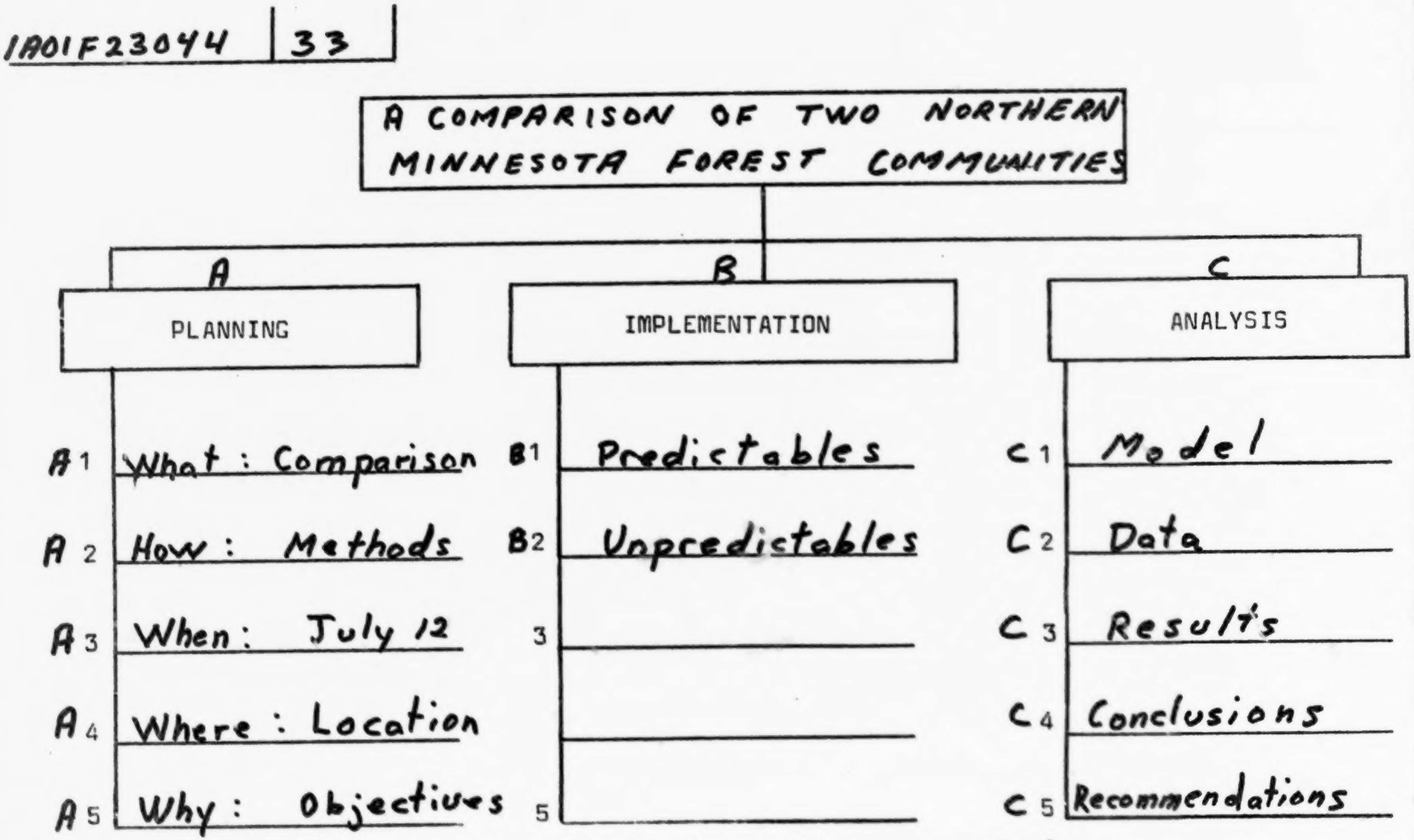

1A01F23044
33
A COMPARISON OF TWO NORTHERN MINNESOTA FOREST COMMUNITIES
A
B
C
PLANNING
IMPLEMENTATION
ANALYSIS
A1 What: Comparison
A2 How: Methods
A3 When: July 12
A4 Where: Location
A5 Why: Objectives
B1 Predictables
B2 Unpredictables
3
5
C1 Model
C2 Data
C3 Result's
C4 Conclusions
C5 Recommendations

Figure D-5. Coded Project Summary Card

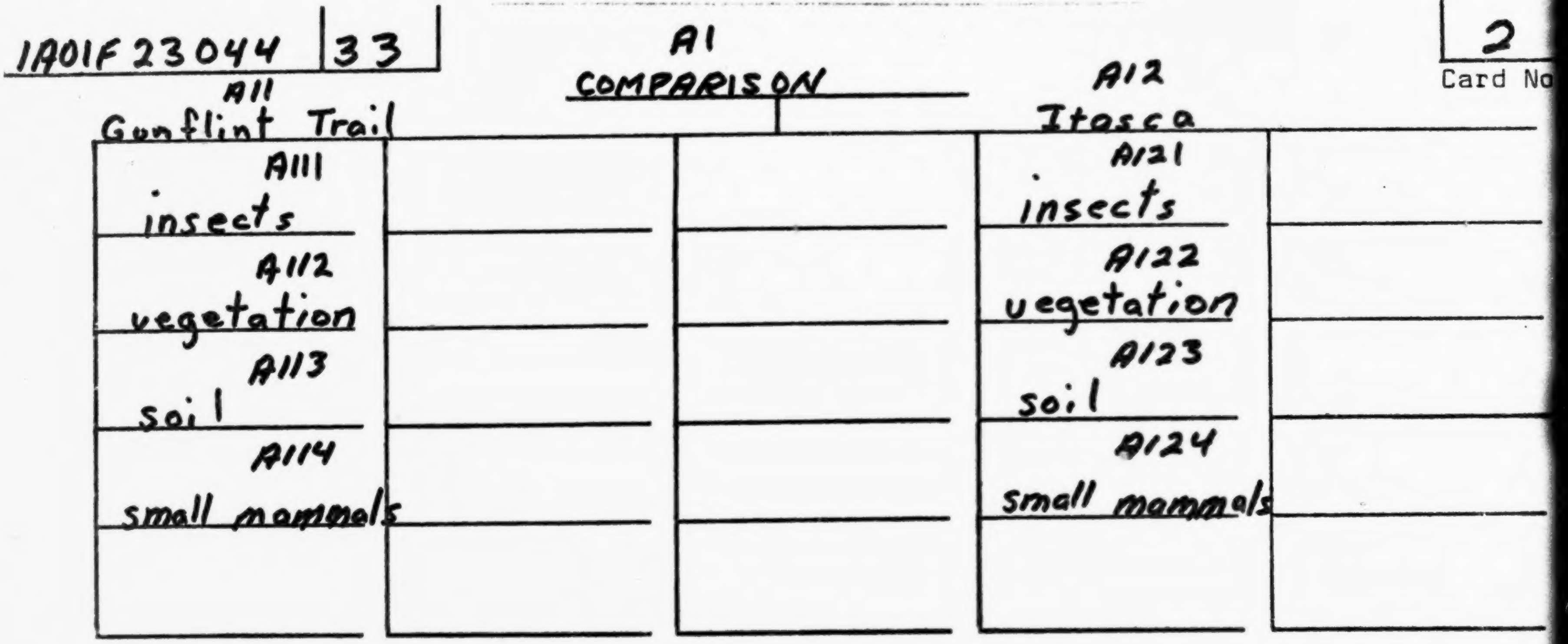

1A01F23044
33
A1
COMPARISON
2
Card No
A11
Gunflint Trail
A111
insects
A112
vegetation
A113
soil
A114
small mammals
A12
Itasca
A121
insects
A122
vegetation
A123
soil
A124
small mammals

Figure D-6. Coded Project Description Card additions can be made without having to retype the complete project. The only typing required after the original typing is adding or correcting, deletions are done on the console. The tapes are also very easy to store, transport and maintain. Any time a particular project is required, the tape storing the project can be placed in the MT/ST and the project data will be automatically typed out.

In the Mobile Science Laboratory evaluation, the MT/ST was invaluable. Every project had to be typed, then the typed copies were sent to the students for editing and correcting when necessary. The edited copies were then returned for corrections. Correcting the projects consisted of playing out the tape containing the project; deleting as applicable, adding or correcting grammar and content. The portions of the typed data that were unchanged automatically typed out.

The 50 magnetic tapes after being used for correcting student projects are a permanent, easily accessible data bank that was provided to the MSL Program as part of the contract. They can be used by the Mobile Science Laboratory committee for demonstrating purposes, examples of student projects, and compact storage containers. They can be modified at any time and still maintain their desired content without re-typing the entirety of the data.

8. Problems in Student Card Usage

Many project cards were hard to read due to lackadaisical writing and use of faint lead pencils. Many parts of outline elements were so terse it was difficult to comprehend the exact meaning. The students, in many instances were not sure where the data collected were supposed to be placed on the cards. Many students felt that they spent too much time on their cards and not enough time on data gathering. Many students felt that the cards should have been larger to allow more room for element qualification. A large number of the students were not aware of exactly how to use their cards properly.

These difficulties are to be expected however, since this was the first year for the students using cards. Many of the students participated this year in the MSL program for their second, third, or fourth time and the change in procedure was unfamiliar.

9. Recommendations for Card Usage

The students should use ink whenever possible and print all the information. They should be more specific on each element of the outline network (three word minimun) i.e. comparison of soil technique, versus just 'soil' for an outline element.

The use of each type of project card should be explicitly defined and illustrated to enhance student comprehension. The cards should possibly be larger to allow the students more space for element qualification.

Some students would like the cards standardized with a definite place to enter all data gathered in the field. However, many students liked the cards exactly the way they were. Possibly, there could be more pre-printed information on the cards so the students would know exactly where to put their data.

One general comment in the card usage is to have the data typed immediately after the field trip so the students can edit the material while the facts are still clear in their mind.

E. Sample Project Write-up

1. Format Description

A Comparison of Two Northern Minnesota Forest Communities number (1A01F2304433) is an example of a completed project as typed from the MT/ST magnetic tape.

The first page of the project is a direct conversion of Figure D-1 (Project Summary Card). The project summary, planning, implementation, analysis, and each of their sub-elements up to the colons are the front part of the card. For example, in the planning category, A1 Comparison:and analysis, C4 Conclusions:. The card itself limited further information at this level of element break down. From the colon to the end of the phrase appears on the back of the summary card as shown in Figure D-1. For example, the front side, A2 Methods:back of card, mode or procedure. This method was designed to counteract card space limitations.

At the bottom of the first page and the top of the second page of the project is the conversion of the Project Description Card, Figure D-2. The students subdivided A1 Comparison into its component parts of A11 Gunflint Trail and A12 Itasca and further divided Gunflint and Itasca into their component parts. As on the Summary Card, the space limitations required the definitions or qualifying remarks of each subdivision of Gunflint and Itasca to be placed on the back of Project Description Card as shown in Figure D-2.

The Supporting Data and Criteria are Section II and III of this project. Section IIA is a direct conversion of the Supporting Data Card, Figure D-3. The charts are too involved and required too much space to be written on the Project Description Cards. Therefore, they are placed on Supporting Data Cards and referenced through the qualifying remarks at the top of the card. For example, "First Transect, July 30, 3:00 P.M., Transect Three".

The criteria, Section III of the project are a direct conversion of Figure D-4. The criteria are qualified by their preceding code. For example, "A Planning of a project...etc." references the planning on the Project Summary Card. These criteria or explanations are why a student performed a particular operation in carrying out his or her project. In this instance the project is a group project.

2. Project

A COMPARISON OF TWO NORTHERN MINNESOTA FOREST COMMUNITIES

Project No. 1A01F2304433

I PROJECT DESCRIPTION

Project Summary:The purpose of this project is to compare (ecologically) two northern Minnesota forest communities. One community is in Itasca State Park on an island in Squaw Lake. The other community is 600 ft. north of camp #712 on the Gunflint trail, Grand Marais, Minn.

In both communities, similar methods were employed to study vegetation, soils, insects, and small mammals in a 600 ft. by 400 ft. area.

The data will then be analyzed by means of comparisons between the two communities.

A. Planning:scheme of procedure for carrying out the study.
  A.1. Comparison:to illustrate the similarities and differences between Gunflint and Itasca.
  A.2. Methods:mode of procedure.
  A.3. July 12 - Aug 3, 1967 July 15-Aug 2, 1968
  A.4. Location:areas designated for the study.
  A.5. Objectives:reasons for doing the study.
B. Implementation:execution of the planning.
  B.1. Predictables:planned or foreseen events or factors.
  B.2. Unpredictables: unexpected events or factors.
C. Analysis:determing essential features of the study.
  C.1. Model:pattern.
  C.2. Data:information collected during the study.
  C.3. Results:outcome of the study.
  C.4. Conclusions:summing up of the results.
  C.5. Recommendations:other expedients.

A.1. Comparison:to illustrate the similarities and differences of the two areas.
  A.1.1. Gunflint Trail

- A.1.1.1. Insects:any small invertebrate having a segmented body and six legs.
- A.1.1.2. Vegetation:sum total of plant life.
- A.1.1.3. Soil:surface material of the earth.
- A.1.1.4. Small mammals:members of the class Mammalio, Phylum Chordata, order Rodentia

A.1.2. Itasca
- A.1.2.1. Insects
- A.1.2.2. Vegetation
- A.1.2.3. Soil
- A.1.2.4. Mammals

A.2. Methods:modes of procedure, the same for 1967 and 68 studies.

A.2.1. Grid:area within which the sampling to be done.
- A.2.1.1. 600' X 400' area.
- A.2.1.2. 100' X 100' quadrat:area for sampling.
- A.2.1.3. Forest:area of study.

A.2.2. Vegetation
- A.2.2.1. 3 40' transects/quadrat
- A.2.2.2. Collect:unknown types for identification and reference.
- A.2.2.3. Press:place specimens under pressure to dry for preservation.
- A.2.2.4. Identify:use keys to find the names.
- A.2.2.5. Record:types and numbers found.

A.2.3. Soil
- A.2.3.1. Collect:sample soil at 20' and 40' along the plant transect.
- A.2.3.2. Information:humus depth and type.
- A.2.3.3. Analysis:pH, phorphorus, nitrogen, potash content.

A.2.4. Insects
- A.2.4.1. 5 sweeps, with 1 to a transect
- A.2.4.2. Put insects caught in killing jars
- A.2.4.3. Mount:preserve specimens by pinning them to a specia board.
- A.2.4.4. Identify:use keys to find the names.

A.2.5. Mammals

- A.2.5.1. 1967 methods:utilized in the 1967 study at Itasca.
- A.2.5.2. 1968 methods:utilized in the 1968 study at Gunflint.
- A.2.5.1. 1967 methods
  - A.2.5.1.1. 600' X 400' grid.
  - A.2.5.1.2. Stations every 25' with traps.
  - A.2.5.1.3. 3 traps at each station.
  - A.2.5.1.4. Collection twice daily
- A.2.5.2. 1968 methods
  - A.2.5.2.1. 300' X 500' grid.
  - A.2.5.2.2. Station every 50' with traps.
  - A.2.5.2.3. 2 traps at 1 station.
  - A.2.5.2.4. Collection twice daily
  - A.2.5.2.5. Identification:use reference books to find the names.
- A.2.3. Soil
  - A.2.3.1. Collect:collect soil samples to find pH, nitrogen, potash phosphorus content.
    - A.2.3.1.1. Quadrat:area designated for study. 100'x100' study area within the 600'x400' grid.
    - A.2.3.1.2. 20' and 40' on plant transect
    - A.2.3.1.3. Dig to soil:necessary to dig through the litte
    - A.2.3.1.4. Dry:samples left exposed to the air overnight.
  - A.2.3.2. Information:data which was collected.
    - A.2.3.2.1. Humus depth:how far the soil was from the surface.
    - A.2.3.2.2. Type of litter
  - A.2.3.3. Analysis:determination of essential features.
    - A.2.3.3.1. Soil analysis:for pH, nitrogen, phosphorus and potash content.

A.3. Schedule:timetable for the project.

- A.3.1. 1967
  - A.3.1.1. 4 weeks
- A.3.2. 1968
  - A.3.2.1. 4 weeks

A.4. Location:areas designated for the study.

- A.4.1. Itasca State park
  - A.4.1.1. Papoose Island
  - A.4.1.2. Squaw lake
  - A.4.1.3. Forest:scrub
- A.4.2. Gunflint trail
  - A.4.2.1. Forest:northern conifer
  - A.4.2.2. 600 ft. north of camp #712
- A.4.3. Brookside

A.5. Objectives:reasons for doing the study.

- A.5.1. #1
  - A.5.1.1. Gain knowledge
- A.5.2. # 2
  - A.5.2.1. Detect similarities and differences between the Itasca and Gunflint study areas.
- A.5.3. #3
  - A.5.3.1. Needed project

B.1. Predictables

- B.1.1. Schedule
  - B.1.1.1. 1967
  - B.1.1.2. 1968 schedule:the first week there we had lectures by various people working in the Gunflint area to acquaint us with it. The afternoons of the second and third weeks were given to setting up and then studying the gird. The cards were worked upon in the evening.
- B.1.2. Data
  - B.1.2.1. 1967
  - B.1.2.2. 1968
- B.1.3. Data format
  - B.1.3.1. Soils
  - B.1.3.2. Insects
  - B.1.3.3. Plants
  - B.1.3.4. Mammals

B.1.2.1. 1967 data

- B.1.2.1.1. Plants
- B.1.2.1.2. Soil
- B.1.2.1.3. Insects
- B.1.2.1.4. Mammals

B.1.2.2. 1968 data

- B.1.2.2.1. Plants
- B.1.2.2.2. Soil
- B.1.2.2.3. Insects
- B.1.2.2.4. Mammals

B.1.3. Data format:sheet which shows the general type of information to be collected.

- B.1.3.1. Soil
  - B.1.3.1.1. Humus depth
  - B.1.3.1.2. ph
  - B.1.3.1.3. Nitrogen content
  - B.1.3.1.4. Potash content
  - B.1.3.1.5. Phosphorus
- B.1.3.2. Vegetation
  - B.1.3.2.1. Date of collection
  - B.1.3.2.2. Time of collection
- B.1.3.
  - B.1.3.2.3. Location collected
  - B.1.3.2.4. Plant type
  - B.1.3.2.5. Number of plants collected
- B.1.3.3. Insects
  - B.1.3.3.1. Date
  - B.1.3.3.2. Time
  - B.1.3.3.3. Location
  - B.1.3.3.4. Weather at time of collection
  - B.1.3.3.5. Lab work
  - B.1.3.3.6. Type of insect

B.2. Unpredictables

- B.2.1. New factors
  - B.2.1.1. Weather
  - B.2.1.2. Accident

    - B.2.1.3. New tool
    - B.2.1.4. Error
  - B.2.2. Different values
    - B.2.2.1. Off schedule
    - B.2.2.2. Conflicting data
  - B.2.1. New factors
    - B.2.1.1. Weather
      - B.2.1.1.1. Temperature
      - B.2.1.1.2. Rain
      - B.2.1.1.3. Wind
      - B.2.1.1.4. Clouds
    - B.2.1.2. Accident
      - B.2.1.2.1. Broken instrument
      - B.2.1.2.2. Lost data sheet
      - B.2.1.2.3. Sickness
      - B.2.1.2.4. Lost pencil
    - B.2.1.3. New tool
      - B.2.1.3.1. New reference
      - B.2.1.3.2. More effective method
    - B.2.1.4. Errors
      - B.2.1.4.1. Bad reading
      - B.2.1.4.2. Improper documentation
  - B.2.2. Different values
    - B.2.2.1. Off schedule
      - B.2.2.1.1. Load too heavy
      - B.2.2.1.2. Load too light
      - B.2.2.1.3. Interruptions
      - B.2.2.1.4. Resource not available
    - B.2.2.2. Conflicting data
      - B.2.2.2.1. Illogical values
      - B.2.2.2.2. Disagreement with theory
- C.1. Model
  - C.1.1. Plants
    - C.1.1.1. Coefficient of community
    - C.1.1.2. Diversity index ratio

    - C.1.1.3. Dominance
  - C.1.2. Insects
    - C.1.2.1. Coefficient of community
    - C.1.2.2. Diversity index ratio
    - C.1.2.3. Dominance
  - C.1.3. Soil
  - C.1.4. Mammals
- C.2. Data
  - C.2.1. Selecting
    - C.2.1.1. Relevant data
  - C.2.2. Sorting
    - C.2.2.1. Comparison
  - C.2.3. Presentation
    - C.2.3.1. Written
    - C.2.3.2. Numerical
    - C.2.3.3. Research paper
- C.3. Results
  - C.3.1. Plants
    - C.3.1.1. Model
    - C.3.1.2. Number of individuals
    - C.3.1.3. Number of species
  - C.3.2. Insects
    - C.3.2.1. Number of individuals
    - C.3.2.2. Number of species
  - C.3.3. Soil
    - C.3.3.1. pH
    - C.3.3.2. Nitrogen content
    - C.3.3.3. Potash content
    - C.3.3.4. Phosphorus content
  - C.3.4. Mammals
  - C.1.1. Model plants
    - C.1.1.1. Coefficient of community
      - C.1.1.1.1. Expression of similarities of species lists
    - C.1.1.2. Diversity index

- C.1.1.2.1. Ratio between number of species and number of individuals
  - C.1.1.3. Dominance
    - C.1.1.3.1. Most numerous plants
- C.4. Conclusions
  - C.4.1. Plants
  - C.4.2. Insects
  - C.4.3. Soil
  - C.4.4. Mammals
- C.5. Recommendations
  - C.5.1. None

II SUPPORTING DATA for 1968--Gunflint Trail

A. First transect July 30 3:00 PM transect 3

plant type	Number counted
wild sarsaparilla	3
Labrador tea	5
Blindia	2' solid growth of moss
Canada mayflower	34
red osier dogwood	3
jack pine	1
Lycopoduim clavitum	2
bunchberry	38
twinflower	28

B. Second transect July 30 3:00 PM

plant type	Number counted
bunchberry	44
twinflower	42
Blindia	11" solid growth of moss
Lycopodium complanatum	2
violet	1
large leaf aster	12

speckled adler	2
Dicranum	3" solid growth of moss
balsam	1
blueberry	2

C. Third transect

bunchberry	40
twinflower	17
large leaf aster	7
strawberry	1
balsam	2
reindeer moss	3' solid growth of moss
black spruce	2
Canada mayflower	14
Blindia	20' solid growth of moss

A. First transect 2:45 PM July 29 Transect 4

Plant type	Number counted
Lycopodium clabatum	1
wild sarsaparilla	4
bunchberry	24
reindeer moss	scattered
Blindia	3' solid growth
twinflower	7
balsam	3
spruce	1
speckled alder	4
Canada Mayflower	8
black spruce	1
red osier dogwood	1
grass	52

B. Second transect

plant type	Number counted
Canada mayflower	3

speckled alder	3
Dicranum	1' 10" solid growth
spruce	1
bunchberry	24
Blindia	2' 6" solid growth
Lycopodium complanatum	1
twinflower	3
strawberry	4
ground pine	5
blueberry	1
reindeer moss	scattered

C. Third transect

bunchberry	61
balsam	1
strawberry	4
ground pine	7
speckled alder	1
grass	40
mayflower	1
large leaf aster	8
twinflower	6
red osier dogwood	1
cedar	1

A. First transect July 30 1:30 PM transect 7

bunchberry	25
black spruce	2
Canada mayflower	7
grass	12
reindeer moss	1' 8" solid growth
Blindia	6" solid growth
strawberry	3
wild sarsaparilla	1

Lycopodium clavitum	3
red osier dogwood	2
one sided pyrola	1

B. Second transect

plant type	number counted
twinflower	1
balsam	1
violet	1
speckled alder	3
black spruce	1
large leaf aster	8
reindeer moss	2" solid growth
bunchberry	2
wild sarsaparilla	7
birch	3
strawberry	4
blueberry	1

C. Third transect

speckled alder	4
willow	1
low cudweed	12
grass	4
Lycopoduim clavatum	1
golden avens	5
wild sarsaparilla	8
large leaf aster	17
oak fern	2
violet	1

A. First transect July 29 1:30 PM transect 9

Lycopodium complanatum	1
bunchberry	21
strawberry	2

red osier dogwood	3
large leaf aster	6
spruce	1
black willow	2
golden avens	1
Canada mayflower	2
Blindia	10' solid growth

B. Second transect

plant type	number counted
oak fern	1
Blindia	entire transect
bunchberry	20
paper birch	1
spruce	1
twinflower	1
birch	2
ground pine	4
large leaf aster	6

C. Third transect

Blindia	entire
strawberry	1
large leaf aster	6
bunchberry	26
mayflower	2
twinflower	4
black spruce	1
wild sarsaparilla	1
blueberry	2
red raspberry	1

A. First transect July 29 2:15 PM transect 10

bunchberry	19
twinflower	1

Blindia	2' solid growth
Canada mayflower	6
northern honeysuckle	1
black spruce	1
large leaf aster	27
balsam	1
Dicranum	1' 2" solid growth
birch	2
golden avens	1

B. Second transect

plant type	Number counted
birch	1
Blindia	entire transect
bunchberry	40
twinflower	5
Canada mayflower	9
balsam	4
Dicranum	3"
red osier dogwood	1
mountain holly	1
strawberry	9
ground pine	1

C. Third transect

bunchberry	41
mayflower	4
strawberry	1
Blindia	7' growth
wild sarsaparilla	3
violet	1
blueberry	2
large leaf aster	2
paper birch	1
mountain holly	1

A. First transect July 30 2:20 PM transect 13

spruce	5
twinflower	47
bunchberry	53
Canada mayflower	6
speckled alder	5
Dicranum	3"
balsam	4
strawberry	13
Blindia	21' solid growth
Lycopodium complanatum	9
wild sarsaparilla	2
violet	1

carpet of bunchberry and twinflower

B. second transect

plant type	Number counted
bunchberry	32
twinflower	19
spruce	1
Blindia	4" solid growth
Canada mayflower	25
violet	2
golden avens	4
large leaf aster	9
wild sprsaparilla	5
reindeer and Blindia	4' solid growth
strawberry	1
Lycopodium clavatum	3
reindeer moss	5" solid growth

C. third transect

Canada mayflower	25
twinflower	10

bunchberry	41
violet	1
wild sarsaparilla	1
lesser Pyrola	2
strawberry	4
red osier dogwood	3
reindeer moss	17" solid growth
Blindia	15" solid growth
Lycopodium lavatum	1

A. First transect July 25 1:30 PM transect 15

violet	2
twinflower	9
bunchberry	19
strawberry	3
mayflower	8
wild sarsaparilla	3
golden avens	1
Blindia	20' 5" solid growth
Black spruce	1

B. second transect

plant type	Number counted
Blindia	entire transect
twinflower	14
mayflower	9
bunchberry	14
balsam	1
strawberry	1
red raspberry	1

C. Third transect

Blindia	entire transect
bunchberry	18

ground pine	2
balsam	5
mayflower	4
wild sarsaparilla	3
strawberry	3
Lycopodium complanatum	3
twinflower	7
birch	1

A. First transect July 25 2:30 PM transect 17

black spruce	2
bunchberry	16
Canada mayflower	9
balsam	4
paper birch	1
Lycopodium clavatum	1
Blindia	entire transect
twinflower	9

B. Second transect

spruce	5
balsam	2
bunchberry	1
twinflower	14
wild sarsaparilla	3
Canada mayflower	5
quaking aspen	1
ground pine	1

C. third transect

plant type	Number counted
Blindia	20' solid growth
spruce	2
bunchberry	8
strawberry	2

black spruce	1
mayflower	1
twinflower	3
balsam	1
Dicranum	8" solid growth
reindeer moss	4" solid growth

A. July 23 1:30 PM Transect 19 first transect

Blindia	entire transect
bunchberry	35
Canada mayflower	21
twinflower	2
Lycopodium clavatum	2
blueberry	3
orchis	1
reindeer moss	small patch
wild sarsaparilla	1
strawberry	1

B. Second transect

large leaf aster	10
Boletinus pictus	1
Blindia	3' solid growth
twinflower	9
bunchberry	6
Lycopodium clavatum	5
reindeer moss	4" solid growth
lesser pyrola	1
Blindia and reindeer	6" solid growth
Canada mayflower	3
black spruce	3
strawberry	2

C. third transect

plant type	number counted

balsam	2
Blindia	3' solid growth
grass	1
Lycopodium clavatum	5
twinflower	4
strawberry	7
bunchberry	26
Polypelus frondosus	1
reindeer moss	19' solid growth
Canada mayflower	2
red raspberry	1

A. First transect July 23 2:30 PM transect 24

Canada mayflower	14
bunchberry	17
reindeer moss	entire transect
Blindia	entire transect
common high bush	1
blueberry	1
ground pine	2
black spruce	1
twinflower	4
balsam	3

B. Second transect

Blindia	entire transect
twinflower	7
mayflower	7
bunchberry	16
wild sarsaparilla	1
cedar	1
ground pine	3
black spruce	1

C. Third Transect

bunchberry	1
twinflower	12
mayflower	4
Blindia	9" solid growth
black spruce	4

SUPPORTING DATA for 1967 at ITASCA
PLANT STUDY

Plant Names	Sections:	3	4	7	11	13	17	19	22
1. Betulaceae Papryfera		1	-	-	-	-	2	-	-
2. Vitacea bicolor		3	-	-	-	-	2	-	-
3. Toxicodendron radicans		16	6	8	6	-	9	-	16
4. Fragaria virgiana		21	16	1	-	-	1	-	7
5. Galium trifidum		9	3	-	-	-	-	-	-
6. Corylus rostrata		47	52	41	64	75	33	65	19
7. Chamaepericlimenum candense		38	12	4	6	4	-	5	4
8. Orchis rotundifolia		30	18	9	8	9	5	9	-
9. Paerdera vitacea		3	1	5	28	3	30	3	13
10. Viburnum trilobum		2	19	-	-	-	-	-	12
11. Cornus stolonifera		4	5	-	-	-	-	-	-
12. Aster macrophyllus		4	15	46	46	14	47	14	3
13. Violar eriocarpa		1	-	-	-	-	-	-	-
14. Truntalis borealis		-	-	1	1	3	-	2	23
15. Lycopodium complanatum		-	-	-	3	-	2	-	19
16. Cornus rugoan		-	3	-	-	-	6	1	3
17. Rubus strigosus		12	-	-	1	-	1	-	9
18. Querous macrosarpa		-	-	-	-	1	-	-	-
19. Fraxinus nigra		-	-	-	-	-	6	-	1
20. Picea mariana		-	-	-	-	-	-	-	2
21. Pinus strobus		-	2	-	-	-	-	-	-
22. Acer rubrum		1	-	1	-	-	-	-	-

Pyrola secunda	1
Salix nigra	2
Gnaphalium uliginosum	12
Geum strictum	12
Gumnocarpium Dryopteris	3
Petula papyrifera	10
Rubus occidentalis	4
Lonicera villosa	1
Nemopanthus mucronata	3
Pyrola minor	3
Polypilus frondosus	1
Betulea lutea	2
Populus tremuloides	1
Chrysopis mariana	119
Boletinus pictus	1

Dominant plants are:

1. Cornus canadensis
2. Linnaea borealis
3. Maianthemum canadense
4. Chrysopis mariana

PLANT STUDY RESULTS

Diversity Index

Gunflint

$$\frac{\text{number of species}}{\text{number of indiv.}} = \frac{22}{1730} = .0205$$

Itasca

$$\frac{\text{number of species}}{\text{number of indiv.}} = \frac{22}{1097} = .0205$$

Coefficient of Community
Number of species--Gunflint:36
Number of species--Itasca:22

Number of common species:6

$$\frac{6}{39 = 22} = \frac{6}{61} = 9.8\%$$

Gunflint:
Number of species:36
Number of indiv.:1730

Itasca:
Number of species:22
Number of indiv.:1097

Plant Conclusion
Conclusion 1

The similarities in the diversity index indicate that species numbers relations were about the same in each community.

Conclusion II

Diversity indix is low indicating little similarity in species types between Itasca and Gunflint.

Conclusion III

A difference in dominant plants indicates that the Itasca and Gunflint forests represent two different types of forest communities.

Forest communities are dynamic because of disturbances. Fire is such a disturbance.

Some authorities say this area has spruce-balsam climax. But this climax is seldom reached because of fire.
Talk by forest ecologist M.L. Heinselman

SUPPORTING DATA FOR 1968 AT GUNFLINT-INSECTS

Quadrat 4

- TI-Culicidae-1
  - Ceratopogonidae-1
  - Dolichopidae-1
- TI-Simulidae-1
  - Pipunculidae-1
- TIII-Simulidae-1
  - Lauxanidae 3
  - Pipunculidae-1
  - Phoridae 2

Quadrat 7

- TI-no insects
- TII culicidae-1
- TIII-no insects

Quadrat 16

- TI Farmicoidae-1
- TII culicidae-1
  - Pipunculidae-1
- TIII Asilidae-1

Quadrat 22

- TI cheronomidae-1
  - Naucoridae-1
- TII-Eurytomidae-1
- TIII-Culicidae-1
  - Phoridae-2
  - Simulidae-1
  - Muscidae-1

Quadrat 10

- TI-Pipunculidae-2
  - Cheronomidae-1
  - Phoridae
  - Drosophilidae-1
- TII-Simulidae-1
  - Calliphoridae-1
- TIII-Pipunculidae-2
  - Eurytomidae-1
  - Simulidae-1

Quadrat 9

- TI-Eurytomidae-1
  - Phoridae-1
  - Dalichopidae-1
- TII-Lauxanidae-1
  - Phoridae-1
- TIII-Pipunculidae-2
  - Simulidae-2

Quadrat 15

- TI-Ceratopogonidae-1
  - Culididae-1

Quadrat 17

- TI-Culicidae-1
  - Tendipedidae-1

Cicadellidae-1
Simulidae-1
Ichneumonidae-1
Sparassidae-1
3 unknown

TII-Ichneumonidae-1
simulidae-3
Ceratopogonidae-1
Quadrant 19
TI-Culicidae-1
Phoridae-3
TII-Eurytomidae-2
Phoridae-1
Culicidae-1
TIII-Lauxanidae-2
Eurytomidae-1
Culicidae-1
Simulidae-2

1 unknown
TII- Cercopidae-1
phoridae-1
TIII-Pipunculidae-2
Phoridae-2

Quadrant 24
TI-Pipunculidae-3
Simulidae-1
TIII-Culicidae-2
Pipunculidae-4
Tabanidae-1
Aphididae-1
TII-Pipunculidae-1
Eurytomidae-1
Chironomidae

SUPPORTING DATA FOR 1967 at Itasca--INSECTS

Insect Names	3	4	7	11	13	17	19	22
1. Lepidoptera Pyraustidae	1	-	-	-	-	-	-	-
2. Lepidoptera Arotud	1	-	-	-	-	-	1	1
3. Lepidoptera Pyralid	-	2	1	3	2	2	-	-
4. Lepidoptera Satyridae	-	-	1	-	-	-	-	-
5. Homoptera Cercopidae	1	3	1	2	-	-	-	-
6. Homoptera Membracidae	-	1	1	1	-	-	1	1
7. Homoptera Cicadellidae	-	1	1	1	-	-	1	1
8. Hymenoptera Ichnsumonidae	5	-	-	-	-	-	-	-
9. Hymenoptera Braconidae	1	-	-	1	1	2	-	-
10. Hymenoptera Formicidae	-	-	-	1	-	-	-	-
11. Hymenoptera Vespidae	-	-	-	1	-	-	-	-
12. Coleoptera Pyrochroidae	-	1	1	2	-	-	1	-
13. Coleoptera Cercopidae	-	-	1	-	-	-	-	-
14. Coleoptera Hydrophilidae	-	2	-	-	-	-	-	-
15. Coleoptera Mordellidae	-	2	-	1	1	-	1	1
16. Coleoptera Saldides	-	-	-	1	1	-	1	1
17. Mecoptera Panorpidac	-	1	-	-	-	-	-	-
18. Ephemeroptera Ephemerodae	-	1	-	-	-	-	-	1

Insect Study Results

Diversity Index

Gunflint

Number of species	22	
Number of individ.	71	.3099

Itasca

Number of species	18	
Number of individ.	65	.2862

Coefficient of community

Number of species from Gunflint	22
Number of species from Itasca	18
Number of common species	4

Gunflint

Number of species	22
Number of individ.	71

Itasca

Number of species	18
Number of individ.	65

Insect Study Conclusion

Conclusion I

The difference in the two diversity indexes indicates that the speci numbers relations were not quite the same in the communities.

Results for 1968 at Gunflint-Soil

Section	potash	nitrogen	pH	phosphorus
4	7.1%	0%	3	8%
7	8%	2%	3	10%
9	8%	0%	2	10%
10	12%	2%	2.5	9%
15	12%	0%	2	8%
17	12%	0%	2	8%
19	13.3%	2%	3.5	10%
24	14%	2.5%	2	9%

Results for 1967 at Itasca--Soil Study

Chemical Content of Soil and Debris Depth

Sections	Nitrogen	Potash	Phosphorus	pH	Debris Depth
3	2%	2%	28%	5 1/4	9.5 inches
4	2%	2%	26%	4/3	1.3 inches
7	3.5%	2.3%	26%	5 1/4	1.5 inches
11	2%	4%	28%	5 1/2	1.5 inches
13	2%	4%	28%	5 1/4	1.7 inches
17	3.5%	2%	28%	5 1/4	2 inches
19	2%	8%	20%	3/4	1.3 inches
22	2.5%	2%	28%	5 1/4	1.5 inches

The debris was mainly composed of decaying leaves, grass, roots and wood.

Supporting Data for 1968 at Gunflint--Soil

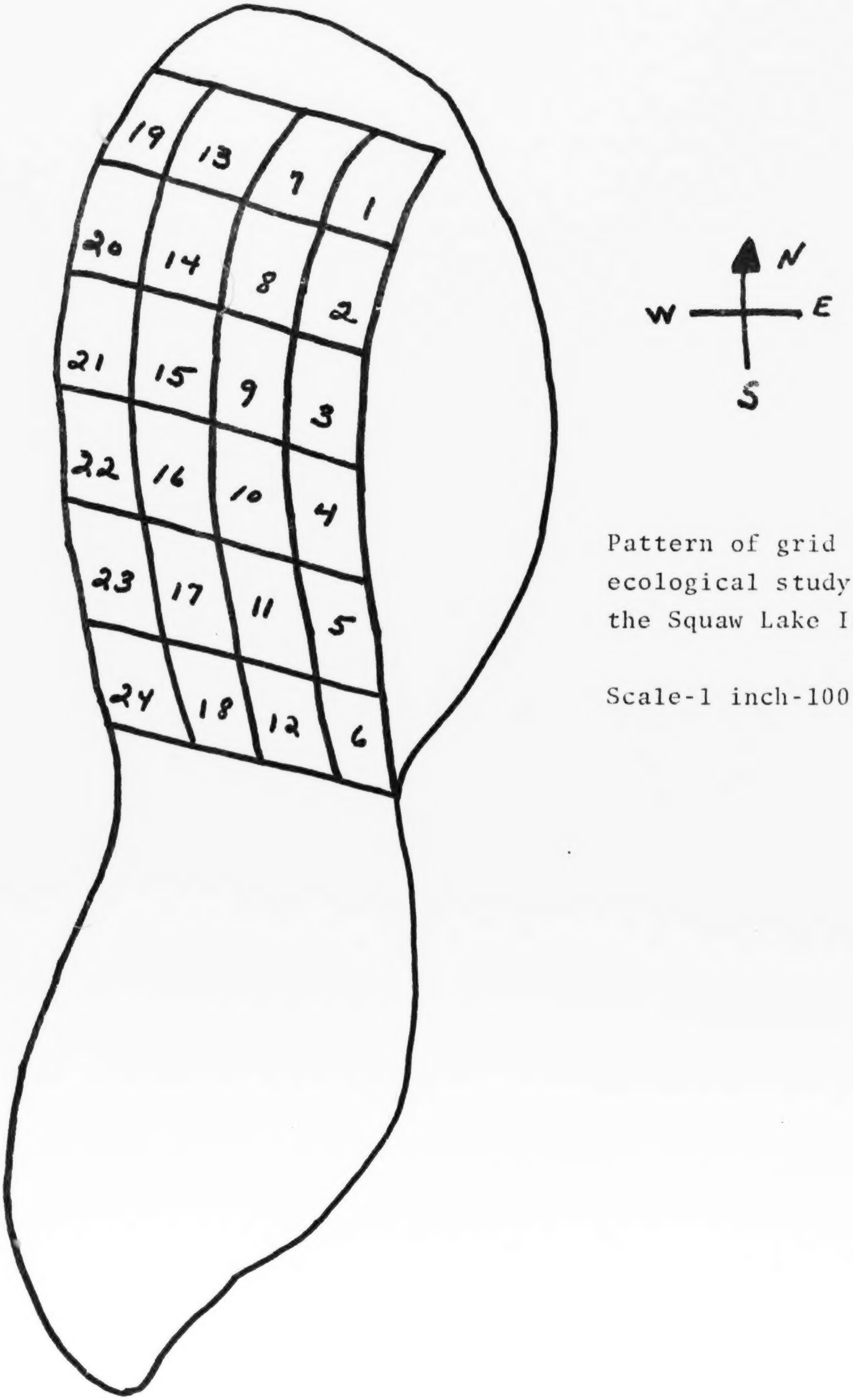
Quadrat	Transect	20' depth	comments	40'depth	comments
4	I	2"	moss carpet	2 1/2"	dry needles, twigs matted
	II	4"	moss carpet, large carbon layer	1 1/2"	dry needles, twigs, under spruce
	III	1"	dry moss	1/2"	dry needles, cones, twigs
10	I	2"	moss carpet, rock	2 1/2"	smallen fallen tree dry needles
	II	2"	moss carpet	3 1/2"	moss carpet
	III	1 1/2"	moss carpet	5"	moss carpet
9	I	1"	moss carpet	6 1/2"	moss carpet
	II	3 1/2"	moss carpet	3"	moss carpet
	III	2 1/2"	sparse moss, dry twigs, CC	4"	moss carpet, rock, CC
19	I	3"	moss carpet	3 1/4"	moss carpet
	II	4"	tree base, dry litter	4"	dry needles
	III	10"	rotten log base	2 1/2"	dry/brittle needles
24	I	5"	dry/brittle litter	3 1/2"	moss carpet
	II	6"	sparse moss carpet	4"	moss carpet
	III	3 1/2"	moss carpet	4"	moss carpet
15	I	2"	moss carpet, some lichen	4"	mixed dry/brittle leaves,moss
	II	1 1/2"	moss carpet, rock	5"	moss carpet
	III	1"	rock	7 1/2"	moss carpet
17	I	2 1/2"	moss carpet	4"	small tree base, mixed moss litter
	II	8"	dry needles, CC	4"	little moss, dry needles
	III	5"	rock, CC	1 1/2"	moss carpet

Supporting data for 1967 at Itasca--Mammals

	Length	Weight	Tail Length	Hind Foot	Ear Length	Scientific Name	Notes
Red-backed mouse	13.6 cm.	16.5 gm	2.8 cm	1.5 cm	.7 cm	Clethrionomys gapperi	parasites in ears
Southern bog lemming	15	35	4	2	.8	Synaptomys cooperi	parasites in ears
Meadow jumping mouse	23	2.53	14.3	3	1	Zapius Hudsonicus	parasites in ears

The above chart shows for each species trapped.

There was evidence of our observations made of woodchucks, Eastern and Least chipmunks, porcupines, beaver, various species of squirrels, muskrats and white-tailed deer on the island.


19
13
7
1
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14
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16
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23
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11
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12
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S

Pattern of grid for
ecological study of
the Squaw Lake Island

Scale-1 inch-100 feet

General Information for 1967 Itasca Study

The data for the study was collected on an island in Squaw Lake, Itasca State Park, Minnesota. Squaw Lake is located in the north-eastern corner of the park, section 5 of Clearwater County.

Papoose Island is found in the southern portion of the lake and is approximately 1200 feet long and 600 feet wide. An average of 501 feet separates the island from the east lake shore. Its distance from the west shore varies from 354 to 897 feet.

The interior of the island is high ground. The east side drops abruptly to a marsh, forming the east shore. The water depth between the island and east shore is rather shallow with waterlilies growing there in abundance. The average depth is 29 feet.

The west side of the island slopes gradually, the shore being abrupt and rocky. Off this shore the average water depth is 39 feet. The northern tip was the reansition zone between the marsh of the east shore and the west shore's abrupt drop.

AN ECOLOGICAL STUDY OF AN ISLAND IN ITASCA STATE PARK, MINNESOTA

III CRITERIA

A. Planning of a project is necessary to ensure efficiency and completeness and to make sure that necessary requirements-tools, location etc., are available.

B. Implementation is necessary so data can be collected for analysis.

C. Analysis is necessary to discover what the data signifies or means.

A.1. Gunflint and Itasca sites are compared because these sites were available to us while working in the Mobile lab summer program.

A.1.1. Insects, vegetation, soils, and mammals were chosen as areas of study because they appeared to us to be the most significant areas in a community study.

A.2.1. A grid is used to facilitate sampling.

A.2.2. Vegetation is studied because it is an important part of the ecological community.

A.2.3. Soil is important in community.

A.2.4. Insects are important in community.

A.2.5. Mammals are important in the community.

A.2.1.5.1. The change between 1967 and 1968 methods was necessitated by the fact that fewer traps were available in 1968 so sampling had to be cut down.